




5.06(76.1)B

The American Museum of Natural History



1869  
THE LIBRARY



Digitized by the Internet Archive  
in 2017 with funding from  
IMLS LG-70-15-0138-15









5.0476.113

# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

VOLUME 40

JANUARY, 1969

NUMBER 1

LIBRARY  
OF THE  
AMERICAN MUSEUM  
OF NATURAL HISTORY



# THE JOURNAL OF THE ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 40

JANUARY, 1969

NUMBER 1

## EDITOR

Robert T. Gudauskas  
Auburn University

## ARCHIVIST

Clyde H. Cantrell  
Auburn University

## EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Paul H. Nesbitt  
Maxwell AFB  
Montgomery

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of the Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

# Contents

## ARTICLES

The Distribution of Striped Bass in Alabama Sam L. Spencer.....	3
The Production and Management of Striped Bass in Alabama H. D. Kelly.....	7
A Sensitive, Precise and Accurate Colorimetric Analysis of Aluminum for Copper Content J. A. Branscomb.....	11
The Design and Performance of a Mössbauer Effect Spectrometer J. F. Rushton.....	19
Capital Budgeting in Local Government Robert J. Juster.....	30
Computer Programming in the High Schools Wallace Hannum and Victor M. Yellen.....	37
Science — A Process Approach or “The Chart Before The Course” Joseph C. Thomas.....	40
A Regression Analysis of the Rate of Off-Farm Migration in the Tennessee Valley Venkareddy Chennareddy.....	47
A New Approach to College Teaching Army Daniel, Jr.....	52
Durability of Glued Finger Joints of Southern Pine D. B. Richards.....	56
Woods for Stropping Razors J. S. Dendy.....	60
A Laboratory Exercise With Seed Germination Thomas Cochis and Kenneth Landers .....	65
Intrinsic Strain Broadening in the EPR and UPR Spectrum of $\text{CaF}_2:\text{U}^{4+}$ in Trigonal Sites Charles M. Bowden and Perry F. McDonald.....	66

# The Distribution Of Striped Bass, *Roccus saxatilis* (Walbaum), In Alabama<sup>1</sup>

Sam L. Spencer  
Alabama Department of Conservation  
Game and Fish Division  
Montgomery, Alabama

## INTRODUCTION

Wherever they occur in sufficient numbers, striped bass, *Roccus saxatilis* (Walbaum), are much sought after by sport fishermen because of their large size and excellent fighting qualities. A few areas in Alabama have been known to support a small to moderate amount of sport fishing for this species in past years. This survey was undertaken to locate and document areas of present and past abundance or occurrence of striped bass in Alabama waters.

## METHODS

Information on the present and past distribution of striped bass was obtained from personal interviews with sport fishermen, commercial fishermen, fishing camp operators, and from written accounts in newspapers and other publications. A total of 160 interviews was conducted from the Alabama Gulf Coast to Demopolis on the Tombigbee River and to Wetumpka and Tallassee on the Coosa and Tallapoosa Rivers, respectively. One-hundred and eleven of those persons interviewed had either caught striped bass or had other information pertaining to striped bass in Alabama waters.

Angling trips and electro-shocking trips were conducted in several areas during times when striped bass were expected to be present.

## RESULTS

Striped bass were reportedly caught in Mobile Bay and all major tributaries and tidal streams that connect to it. Apparently their abundance has declined within recent years. At the time of this survey it appeared that there was no striped bass fishery of any consequence in Alabama.

Data from the interviews are presented by stream systems.

### The Gulf of Mexico

No striped bass have been reported as caught by sport fishermen in the Alabama portion of the Gulf of Mexico. Only one report of a striped bass being caught in the Alabama Gulf by commercial fishermen was obtained. This fish was caught in the surf in a net near the mouth of Little Lagoon in 1951.

### Perdido Bay and Tributaries

No striped bass catches were reported by either sport or commercial fishermen in Perdido Bay. However, catches of striped bass were reported from one of the tributaries, Sandy Creek, 15 or more years ago.

<sup>1</sup> This project was financed in part with Anadromous Fish Act (P.L. 89-304) funds through the Bureau of Sport Fisheries and Wildlife.

Striped bass have been caught in two other tributaries, Perdido and Styx Rivers, within recent years. Although the striped bass fishing has experienced a rapid decline in the past three years, one 18-pounder was caught in the Perdido River in December, 1966.

### Mobile Bay

Most Mobile Bay commercial fishermen contacted had previously caught striped bass. Those who had fished for many years agreed that the striped bass population had declined and most reported that it had been at least four or five years since they caught one. Very few striped bass were reportedly caught in the lower portions of the bay. Most were caught either near the mouth of tributary streams or in the bay during periods when large amounts of fresh water were entering the bay. As the bay waters became saltier, the striped bass apparently moved up into the tributary streams of the Mobile Delta.

No reports of an angler-caught striped bass in Mobile Bay were located.

### Tidal Streams and Rivers of Mobile Bay

Striped bass were reportedly caught in all five tidal rivers which enter Mobile Bay south of the Mobile Causeway. These are East Fowl and Dog Rivers on the west side; Fish, Magnolia, and Bon Secour Rivers on the east side of the bay. This fishery has declined greatly within the past 25 years and only a few striped bass had been caught within the last four or five years.

Striped bass were reported from all major tributaries which connect to Mobile Bay (Figure 1). Striped bass have been caught in practically all of the rivers, bays, bayous, and streams which make up the Mobile Delta.

Tidal streams such as Bay Minette Creek, Chickasaw Creek, Bayou Sara, Gunnison Creek, and some of the larger streams such as Tensaw River, Tensaw Lake, Mifflin Lake, and Hastie Lake apparently supported a sport fishery for this species at one time. This fishery was reported to have declined within recent years to the point where striped bass catches were considered rare.

### Major River Systems

Striped bass have been reported from the major river systems which have connection with Mobile Bay.

#### Tombigbee River

A written report and photograph were obtained of a 24-pound striped bass that was caught in a net in the Tombigbee River near Demopolis in 1926. Striped bass are occasionally caught in the Tombigbee River in the tailwaters below Demopolis Lock and Dam and below Jackson Lock and Dam. A few striped bass were caught in Lake Demopolis in the late 1950's.

#### Alabama River

Striped bass reportedly were caught in the upper Alabama River above Montgomery as recent as April 14, 1967 when 10 were caught and released from hoop nets by one commercial fisherman. However, this fisherman also reported that their abundance had declined in recent years.

Catches of striped bass were reported from all portions of the Alabama River. Most fishermen agreed that the fishery had declined and it had been several years since they had caught one.





FIGURE 1. Distribution of striped bass in Alabama. Darkened portions indicate waters where striped bass have been reported.

### Coosa River

The Coosa River below Jordan Dam at Wetumpka supported a small striped bass sport fishery from 1931 until recent years. One sport fisherman reported that he had caught several hundred large stripes but that he had not caught any in recent years.

The July, 1931 issue of Alabama Game and Fish News reported that several striped bass (rock-fish) had been caught in the river at Wetumpka, many of them weighing 20 pounds and more. The June, 1934 issue contained the following statement. "The sea bass being caught in the Coosa this year are said to be larger than ever before. The first one caught there was in 1931 . . ." "For a time they didn't know what kind of fish was breaking their lines and galloping off with their lures, and only when they began to use stronger lines and lures did they find out."

### Tallapoosa River

The Tallapoosa River below Thurlow Dam at Tallassee supported a fair sport fishery for striped bass from 1951 to 1962. During this period one fisherman reported that he caught over 500 striped bass. At the time of this survey, fishing had declined to the point that he no longer fished for these fish. The largest striped bass caught by angling weighed 55 pounds. One caught in a net about 1957 weighed 76 pounds. These fish apparently migrated to this area to spawn. They generally arrived in late April or early May and some remained as late as October.

Two substantiated catches were made at Tallassee during 1966. Four striped bass between 2.25 pounds and 30 pounds were caught during 1967 by sport fishermen.

## SUMMARY

The survey revealed that in past years fishermen have caught-striped bass in Mobile Bay, Perdido Bay, and most major tributaries and tidal streams which connect to Mobile Bay. Only one striped bass catch was reported from the Gulf of Mexico.

Two of the better striped bass sport fisheries in past years were at Wetumpka on the Coosa River and at Tallassee on the Tallapoosa River between 1951 and 1962. From the interviews it was very evident that the number of striped bass has declined greatly in Alabama. At the time of this survey, there was no striped bass fishery of any consequence anywhere in the state.

# The Production And Management Of Striped Bass, *Roccus saxatilis* (Walbaum), In Alabama<sup>1</sup>

H. D. Kelly  
Alabama Department of Conservation  
Game and Fish Division  
Montgomery, Alabama

## INTRODUCTION

On November 12, 1941, the water of the Santee River in South Carolina was impounded and diverted to form the Santee-Cooper Reservoir. The Santee and the Cooper Rivers had a history of seasonal runs of the striped bass, *Roccus saxatilis* (Walbaum), from the ocean prior to the impoundment. Soon after the impoundment was completed, isolated catches of striped bass were reported from within the reservoir and by 1950 the bass were appearing in schools. It was first thought that the presence of the large number of stripes in the lake was due to the Pinopolis Navigation Lock. Scruggs and Fuller (8) discounted this possibility by the use of trammel nets in the lock, and Scruggs (7) revealed through further investigation that the stripes were reproducing above the lake in the rivers. The situation was unique in that an annual fishery of striped bass was maintained to a great extent by the spawning of a resident population. Prior to this it was thought that the stripe had to return to salt water to develop. Today, the Santee-Cooper system provides the most important fresh water fishery for the striped bass in the Eastern United States. In the 16 years immediately following the impoundment of the Santee River, the popularity of the striped bass and its reception by fishermen, not only in South Carolina but all over the country, led one fishery worker to estimate that the presence of the striped bass in the Santee-Cooper Reservoir was worth millions of dollars to the people of South Carolina.

Reports of the success and popularity of the striped bass in South Carolina were received with great interest among the fishery workers across the nation. This tremendous interest precipitated many research projects designed not only to study the striped bass but to develop means of producing the stripe bass in hatcheries and other systems.

## LITERATURE REVIEW

Studies of the striped bass have been widespread in this country. Calhoun (2) and Calhoun, *et al.* (3) reported studies from California; Merriman (5) from the Atlantic coast. These along with the works of Hollis (4), Treselt (14), Raney (6), and Vladykow (15) have made excellent contributions to our biological knowledge of the species. Among more recent contributions are those of Alperin (1) and Talbot (12), both in 1966. Apparently Scruggs and Fuller (8) and Scruggs (7) were the first to report the possibilities and likelihood of a reproducing landlocked population. Stevens (9) in studying the unique situation in the Santee-Cooper found that: the stripe fed almost exclusively on Clupeoid fishes present there except for the an-

<sup>1</sup> This project was financed in part with Anadromous Fish Act (P.L. 89-304) funds through the Bureau of Sport Fisheries and wildlife.

nual period of April, May, and June, when mayfly nymphs became the principal food item; (2) striped bass grew all year to some extent with annulus formation apparently taking place in February; (3) the striped bass rapidly became a favorite with the fishermen; and (4) the striped bass in the Santee-Cooper exerted a desirable influence on the ecology of the total fish population.

The combined traits of popularity and shad control gave rise to tremendous demands for the striped bass from fishery workers across the nation. The limitations of the old method of collecting ripe fish for stripping and the need for and the development of hormone induced ovulation in striped bass are discussed by Stevens and Fuller (11), Stevens (10), and Tatum, *et al.* (13). With the development of the use of hormones, large numbers of stripe eggs and fry became available for fishery workers. Millions of fry have now been stocked in reservoirs across our nation in an effort to establish striped bass populations. Apparently, these efforts have failed due to a very low survival of the stocked fry. Many agencies are now conducting experiments relative to the rearing of fry to a fingerling size for stocking which hopefully will result in a higher survival of stocked stripes.

## PROCEDURES AND RESULTS

The work performed in this study by fishery biologists of the Alabama Department of Conservation constitutes our first active attempts at working with the eggs and fry of the striped bass with applications toward pond rearing techniques.

On April 19, 1967, 50,000 eggs (estimated) and 50,000 fry (estimated) of striped bass were obtained from the hatchery at Monck's Corner, South Carolina. The eggs and fry were transported in plastic bags with an oxygen atmosphere by aircraft and no difficulty was encountered during the trip to the Eastaboga Fish Hatchery, Eastaboga, Alabama.

Upon arrival at the hatchery, water chemistry tests indicated a remarkable similarity between the water in the bags of fry and eggs and the water supply of the hatchery. Eight 15-gal. aquaria appropriately equipped with air and water supplies had been prepared to receive the fry and eggs.

The eggs were divided between two aquaria utilizing air for circulation. This procedure worked very effectively until a branch supply line became partially clogged allowing the eggs to settle. There was a loss of eggs estimated at 70 percent in each aquarium. This incident seemed to trigger a continual loss of eggs as no loss had occurred prior to this. Eventually all eggs were lost.

The fry were divided among four aquaria and no problems were encountered during the entire holding period from April 19 to April 22. Air was the only means used to keep the fry suspended or moving since it was thought that the principal waste product to be encountered would be  $\text{CO}_2$  and no water exchange would be necessary.

Fry were removed periodically and observed to note the development of the gut and mouth parts. On the evening of April 21 it was evident that the gut would be open and the mouth parts functional sometime within the next 12 hr. In the early morning of April 22 the fry were observed to have functional mouth parts and the gut had completed development. The fry were immediately transferred to a one-acre pond which had received 1,000 lb of

Johnson grass-bermuda hay on April 10 and filled with water immediately thereafter. The preparation of the rearing pond was postponed as long as possible to prevent the development of populations of predacious aquatic insect forms. Subsequent examinations of the pond water prior to the introduction of the fry revealed an excellent culture of Infusoria. It was thought that the Infusoria would provide a desirable source of food for the fry as they began to take natural food items. Examinations of the pond water following the introduction of the fry revealed that an excellent population of *Cladocera* and related forms continued to develop in the following weeks thus providing advanced food items for the developing fry.

No evidence of fry survival was found until the week of May 14. Subsequent observations revealed increasing numbers of small stripes and a decreasing food supply. On May 24, 1,500 fathead minnows, *Pimephales promelas*, varying in length from three to five in. were stocked in the pond in an effort to provide forage for the young stripes which were now one to one and one-half in. in length. The fatheads were observed spawning the next day but no small fatheads were ever found. When it became evident in early June that the fatheads would not provide enough forage for the surviving stripes, supplemental feeding was initiated using a dry, balanced trout food. Feeding was continued through September when it was obvious that the stripes had ceased taking the food.

By mid-October, *Spirogyra* sp. had become so abundant in the pond that draining was initiated. Of an estimated 45,500 fry placed in the pond 3,402 were recovered which varied in length from three to ten in. During August, 3,000 stripes had been removed from this pond and placed in another. Draining of that pond the next week yielded an additional 2,010 stripes for a total survival of 5,412 fish varying in length from three to ten in.

## DISCUSSION

The seemingly low survival, approximately 11 percent, for the six month study period compares favorably with many other attempts elsewhere. It is now believed that our losses occurred principally in the fry stage and in the latter portion of the study when cannibalism undoubtedly resulted in the loss of great numbers of small stripes. No significant numbers of dead stripes were ever observed in the pond. In mid and late summer when water surface temperatures approached 90 F., there were some losses of fish which we attributed to temperature. During periods of high water temperatures no stripes were found in the margins of the pond and neither would they feed.

It appears from this study that supplying proper food items in adequate amounts in the culture of the young stripe will be a problem since the number of fish present is not known and there is a decided preference for natural foods. The fathead may supply proper forage in numbers greater than 1,500 per acre where large numbers of fry are present.

All except 200 of the surviving fishes of this study were placed in Lake Martin in Tallapoosa County where efforts are being made to establish a spawning population through the stocking of fingerling striped bass. Prior to the 1967 stockings from Eastaboga there were stockings made from Auburn University, Auburn, Alabama. To date the total number of striped bass stocked in Lake Martin is 6,046. There have been three verified catches of the fish from Lake Martin since the initial stocking in 1966 and the length-



weight relationships indicated that the fish have found a favorable habitat in Lake Martin. Should the requirements for striped bass reproduction be present in the Tallapoosa River above Lake Martin, spawning runs could occur in 1969 but most likely it will be 1970 before runs of any significance are made.

#### LITERATURE CITED

1. Alperin, Irwin M. 1966. Dispersal, migration and origins of striped bass from Great South Bay, Long Island. New York Fish and Game Journal, 13(1): 79-120.
2. Calhoun, A. J. 1952. Annual migrations of California striped bass. California Fish and Game 38(4): 391-403.
3. Calhoun, A. J., C. A. Woodhull, and W. C. Johnson. 1950. Striped bass reproduction in the Sacramento River system in 1948. Calif. Fish and Game 36(2): 135-45.
4. Hollis, E. H. 1952. Variations in the feeding habits of the striped bass, *Roccus saxatilis* (Walbaum), in Chesapeake Bay. Bull. Bingham Oceanogr. Collection 14 (1): 111-131.
5. Merriman, Daniel. 1941. Studies on the striped bass (*Roccus saxatilis*) of the Atlantic Coast. U.S. Fish Wildlife Service, Fish. Bull. 50(35): 77pp.
6. Raney, E. C. 1952. The life history of the striped bass, *Roccus saxatilis* (Walbaum). Bull. Bingham Oceanogr. Coll. 14(1): 5-97.
7. Scruggs, G. D., Jr. 1955. Reproduction of resident striped bass in Santee-Cooper Reservoir, South Carolina. Trans. Am. Fish. Soc. 85: 144-159.
8. Scruggs, G. D., and J. C. Fuller, Jr. 1954. Indications of a freshwater population of striped bass, *Roccus saxatilis* (Walbaum), in Santee-Cooper Reservoirs. Proceed. Southeastern Assn. Game and Fish Commissioners 8: 64-68.
9. Stevens, Robert E. 1957. The striped bass of the Santee-Cooper reservoir. Proceed. Southeastern Assn. Game and Fish Comm. 11: 253-264.
10. Stevens, Robert E. 1964. A final report on the use of hormones to ovulate striped bass, *Roccus saxatilis* (Walbaum). Proceed. Southeastern Assn. Game and Fish Comm. 18: 525-38.
11. Stevens, Robert E. and J. C. Fuller, Jr. (Undated) A preliminary report on the use of hormones to ovulate striped bass. *Roccus saxatilis* (Walbaum). South Carolina Wildlife Resources Department. 31pp.
12. Talbot, Gerald B. 1966. Estuarine environmental requirements and limiting factors for striped bass. Am. Fish. Soc. Special Pub. No. 3: 37-49.
13. Tatum, Buford L., Jack D. Bayless, Edward G. McCoy, and William B. Smith. 1965. Preliminary experiments in the artificial propagation of striped bass, *Roccus saxatilis*. Proceed. Southeastern Assn. Game and Fish Comm. 19: 374-89.
14. Tresselt, E. F. 1952. Spawning grounds of the striped bass or rock, *Roccus saxatilis* (Walbaum), in Virginia. Bull. Bingham Oceanogr. Collection 14(1): 98-110.
15. Vladykow, V. D. 1952. Studies of the striped bass, *Roccus saxatilis* (Walbaum), with special reference to the Chesapeake Bay region during 1936-1938. Bull. Bingham Oceanogr. Collection 14(1): 132-177.

## A Sensitive, Precise, And Accurate Colorimetric Analysis Of Aluminum For Copper Content

J. A. Branscomb  
Reynolds Metals Company  
Reduction Research Division  
Sheffield, Alabama

### INTRODUCTION

Aluminum is produced commercially by the electrolytic reduction of alumina, thus current efficiency is an important index of the operation of a reduction cell. Current efficiency is the ratio of the amount of aluminum produced during a period of time to the amount theoretically possible. The theoretical production is calculated by Faraday's law from the total current used during the test period.

To ascertain production during a test period, the weight of metal tapped must be adjusted for any change in the reserve of molten aluminum normally maintained in each cell. The reserve can be measured by adding a weighed amount of a suitable element (for example, copper) and analyzing samples of the molten aluminum taken before and after the addition (7). The amount of aluminum produced during succeeding test periods can be calculated from the corresponding dilution of the trace element added.

One limitation to the dilution technique is that the addition of any element decreases the purity of virgin aluminum, so it is necessary to add the smallest amount that will enable these calculations to be made. A second handicap to the technique is that the amount of aluminum produced per cell per day is relatively small compared to the amount in reserve in each cell. A third factor is that the accuracy of the calculation of metal reserve must exceed whatever degree of accuracy is wanted for the calculated current efficiency. This is to allow for possible errors in weighing the metal tapped, in measuring the current used, etc.

These three factors prevent a satisfactory calculation of current efficiency for short periods from trace metal dilution, unless an extremely sensitive, precise, and accurate analytical method is available.

It was concluded from a survey of literature that the sensitivity and accuracy reported for the diethyldithiocarbamate method most nearly approached the exacting requirements of the dilution technique.

### RRD METHOD STP-CU-1-67

Detailed procedures for the Reduction Research Division Method STP-Cu-1-67 can be obtained by writing the author. In the following paragraphs, some unique characteristics and advantages of the method are discussed.

In addition to the resulting beneficial modifications made in the diethyldithiocarbamate method, precision and accuracy are greatly enhanced by techniques in its application developed by Reduction Research Division. Excellent sensitivity is achieved without having to concentrate the copper content by extraction with an organic solvent, or by separation from the aluminum by filtration. The entire analysis to the point of filling the cuvette for reading the optical density can be done in a volumetric flask, (Option B),

eliminating the possible sources of inaccuracy from loss in pipetting and from transferring from one container to another. The use of volumetric flasks as the sample container in both Options reduces the chance of loss from within, and contamination from without.

The addition of all reagents with dispensing burettes and pipettes insures uniform concentrations among the samples and standard solutions used to establish and maintain the standardization line of the relationship between optical density and concentration of copper.

Selecting suitable sample weights and volume of aliquots insures the same concentration of copper in all portions being read with the spectrophotometer, or colorimeter, and all portions tested contain the optimum amount of copper for this method. This permits the use of only two standard solutions to bracket the concentration of copper in the samples and makes it easier to detect changes in slope of the calibration line.

The use of pHdrion indicator paper with the glass stoppers is a simple and fast way of adjusting the pH of the solution without using a pH meter, or having portions of the indicator paper in the solution. Indicator paper remaining in the solution can increase the optical density of the background.

The color of the copper complex was found to be stable over a period of 17 hr. If something interrupts the analysis after the diethyldithiocarbamate is added, the samples can be read satisfactorily the following day.

The stability of the solution after its acidification with HCl is satisfactory for months. This permits making a solution of a standard aluminum sample by Option A and keeping it for use in checking the line daily. This provides the advantage over standard solutions of copper of having aluminum as the matrix, and in having the same interfering elements as the samples.

Beer's law (8) was found to apply for the range studied up to 0.35 mg of copper/250 ml of solution.

## APPLICATION OF THE METHOD

### *Sensitivity*

The sodium diethyldithiocarbamate method is one of the most sensitive for measuring copper. The method has been used to detect 0.0002 mg of Cu/ml of water (8). An indication of the sensitivity and accuracy of this revision of the method, based on standard solutions of pure copper dissolved in two solvents, is provided in Table 1.

### *Precision*

An indication of the precision of analyses of aliquots from solutions of pure copper in three solvents and of the stability of these dilute standard solutions with low concentrations of copper, is provided in Table 2. The solutions were found to be stable for the period tested—up to five months. Another indication of the precision of the analyses of aliquots from the solution of five gs of aluminum, and the stability of the acidified solutions of aluminum is provided in Table 3. A comparison with the precision and accuracy of quantometric analyses is provided in Table 4.

### *Accuracy*

Three criteria were used for appraising the accuracy of the method.



## Accuracy Based on the Use of Standard Solutions of Copper

Only an indication of the accuracy of this method could be obtained. Standard solutions of copper wire, shot, or crystals do not contain any alumi-

TABLE 1. Indicated sensitivity and accuracy using standard solutions

Standard used	Copper added	Copper measured	Difference, absolute error	Relative error, %
	$\text{g} \times 10^{-5}$	$\text{g} \times 10^{-5}$	$\text{g} \times 10^{-5}$	
Copper wire dissolved in nitric acid.	1	1	0	0
	1	1	0	0
	2	2	0	0
	2	3	+1	50
	5	6	-1	20
	5	5	0	0
	10	10	0	0
	10	8	-2	20
	25	26	+1	4
	25	23	-2	8
	50	53	+3	6
CuSO <sub>4</sub> - 5H <sub>2</sub> O crystals dissolved in water.	50	50	0	0
	100	100	0	0
	1	1	0	0
	2	2	0	0
	2	2	0	0
	5	5	0	0
	5	5	0	0

TABLE 2. — Indicated precision of method and stability of dilute, standard solutions of copper

Standard solutions containing $1 \times 10^{-5}$ g Cu/ml.							
Source of copper	Date analyzed	Optical Density					
							Average
1. Copper wire in tri-acid solution. 11/1/66	4/4/67	.077	.076	.077	.075	.075	0.076
2. Copper wire in nitric acid solution. 11/16/66	4/4/67		.078	.078	.075	.075	0.076
3. CuSO <sub>4</sub> - 5H <sub>2</sub> O water solution. 2/17/67	4/4/67		.076	.076	.075	.075	0.076

TABLE 3 — Indicated precision of method and stability of solutions of aluminum used

Alcoa spectrographic standard SA 2149. Certificate copper content: 0.10 %						
	Date	Copper found, %				
						Average
Sample taken into solution:	6/06/67					
First aliquots tested:	6/15/67	.1012	.1012	.1012	.1022	0.1015
Additional aliquots tested:	7/27/67		.1022	.1012		0.1017
Alcoa spectrographic standard SA 2273. Certified copper content: 0.21 %						
	Date	Copper found, %				
						Average
Sample taken into solution:	5/25/67					
First aliquots tested:	6/06/67	.2126	.2090	.2116	.2118	0.2113
Additional aliquots tested:	7/28/67	.2102	.2089	.2138	.2138	0.2117

TABLE 4. Precision and accuracy compared with quantometric analyses

Alcoa standard SA 2266, 0.005 % copper		Alcoa standard SA 2053, 0.033 % copper		Alcoa standard SA 2273, 0.21 % copper	
Chemical	Quantometer	Chemical	Quantometer	Chemical	Quantometer
.0061	.0054	.0371	.034	.2126	.204
.0059	.0055	.0370	.034	.2090	.206
.0059	.0056	.0371	.036	.2116	.209
.0059	.0058	.0369	.036	.2118	.212
.0056	.0059		.037	.2102	.213
.0055	.0053		.034	.2089	.208
.0056	.0055		.035	.2138	.209
.0060	.0053		.036	.2138	.211
	.0056		.036		.212
	.0058		.037		.212
<hr/>					
Mean:					
.0058	.0056	.0370	.036	.2115	.210
Std. deviation:					
±.0002	±.0002	±.0001	±.002	±.0019	±.002

num or interfering elements encountered in the samples. There is the possibility of errors in the assay of the pure copper; in preparing the standard solution from the small amount of copper; diluting the solution to volume; pipetting 5 or 10 ml and diluting to volume; then using pipettes with a capacity of 1, 2, 3, 4, or 5 ml to obtain portions for analysis; and finally, in analyzing the standard solutions. These possible errors handicap the use of these standard solutions as the source of a true value of copper when an accuracy of  $\pm 0.0001$  percent is desired.

#### Accuracy Based on the Use of Solutions of Aluminum Spectrographic Standards

The use of solutions of aluminum spectrographic standard samples also has disadvantages for use in this method. Among the best available are those provided as a service to industry by the Aluminum Company of America. These are stated by Alcoa to be intended specifically for use as spectrographic standards. Their use as standards for other purposes must be determined experimentally for each occasion. A second handicap is that the certified value over the range required in using the dilution technique is only reported to the nearest 0.001 percent from 0 to 0.10 percent and only to the nearest 0.01 percent from 0.10 to 0.20 percent. Consequently, these standards cannot be used to determine the accuracy of analyses reported to the nearest 0.0001 percent. An unexpected difficulty found with the Alcoa standards used was that some in solution had the same relationship of optical density to concentration of copper as did the standard solutions of copper not containing aluminum. Others did not, and their resulting calibration line had a different slope. This resulted in an indicated higher accuracy for this method based on the standard samples which had the same relationship of optical density to concentration as the copper solutions had (Table 5). Any Reduction Research Laboratory's analyses would be the same as Alcoa's if they were rounded off to the same number of decimal places, indicating perfect accuracy for this method to the third decimal place up to 0.10 percent and to the second

decimal place from 0.10 to 0.20 percent. Any single answer obtained by RRL was within the range of ten numbers that Alcoa may have obtained before rounding off analyses to the third or second decimal place. The first two standards in Table 4 are two which, in solution, were found to have a different relationship of optical density to content of copper. The quantometric values reported in Table 4 for these two standards, which indicate a poorer accuracy for this method, were in closer agreement with RRL's spectrophotometric answers than with Alcoa's, although other Alcoa standards are used for standardization of the quantometer. No explanation could be found for the solutions of different groups among the Alcoa standards producing lines with different slopes.

Another liability in the use of spectrographic standards for measuring the accuracy of this method is that they contain many elements not found in pot-room metal, some of which can interfere with the diethyldithiocarbamate method, although this revision was designed to prevent this.

#### Precision and Accuracy Based on the Aluminum Metal Inventory of RRD's Experimental Cells

Another indication of the accuracy of this method is provided by comparing the molten reserve of aluminum, calculated from the application of this

TABLE 5. Indicated accuracy and precision using solutions of Alcoa's Spectrographic Standards

Alcoa's designation	Copper Content, %		
	Alcoa's certified analyses	Possible range* in Alcoa's analysis	RRD's analyses on different dates
SA1050-3	0.042	0.0415-0.0424	0.0428
			0.0424
			0.0416
			0.0422
			0.0424
SA2149	0.10	0.0950-0.1049	0.1012
			0.1012
			0.1021*
			0.1012
SS1100AE	0.16	0.1550-0.1649	0.1550*
			0.1599
			0.1596
			0.1582
			0.1594
SA2273	0.21	0.2050-0.2149	0.1591
			0.2126
			0.2090*
			0.2116
			0.2118
			0.2113
			0.2117

\*Discarded by Goodwin's Test.

\*Alcoa's values if reported to 4 decimal places may have been any of these percentages.

method, with the amount tapped and dug from the cell. This comparison includes many possible errors: failing to recover all the metal; in weighing the metal; segregation of copper within the cell; copper lost from the molten metal; sampling; non-homogeneity of the sample; plus errors of analysis.

Circumstances favored the use of metal inventory as a basis for assessing the accuracy and precision of this method. Four experimental 10,500 amp. cells at Reduction Research were tested using the dilution technique. Samples were taken at the same time from two sides of the cells, at intervals between the addition of the copper and shutting down the cells. Eight samples were taken at the same time from two of the cells immediately before the cells were shut down. These samples were interspersed among the series of samples taken at different intervals of time after the addition of the copper. However, they were assigned numbers in sequence with the rest of the series. This resulted in some samples which were taken at the same time being analyzed in different batches, on different days, and by three different analysts. The excellent precision of the analyses of these samples which represented all the operational variables listed above, plus possible errors of analysis, appears a tribute to the method, its application in the laboratory, and the application of the dilution technique in the RRD potroom. This degree of precision is illustrated in Table 6. If the one suspect value among the analyses of the four samples taken at the same time on each side of the cell were rejected at the 97.5 percent confidence level, using Goodwin's statistical criterion (4), the mean and the standard deviation for the copper content of the east side would be 0.0215 percent Cu  $\pm$  0.0001 percent, and for the west side 0.0216 percent  $\pm$  0.0002 percent, or only 0.0001 percent difference found in copper content and standard deviation for both sides of the cell at the same time. The percent standard error would then be 0.93. The average weight calculated for the reserve of aluminum would then be 1,318 lb, and the accuracy of the prediction of the amount of aluminum

TABLE 6. Accuracy and precision using the weight of aluminum removed from a 10,000 amp cell as a standard

	Copper Content, %				Weight of aluminum calculated from Cu analysis, lbs
	Before addition		24 hr after addition		
	East side	West side	East side	West side	
	0.0041	.0041	.0216	.0218	1318
	0.0043	.0041	.0214	.0214	1295
			.0219°	.0217	1333
			.0215	.0223°	1333
					1295**
					1303
					1325
					1260**
Average.	0.0042	.0041	.0216	.0218	1308***
Standard deviation:			±.0002***	±.0003***	± 27***
Percent standard error:			.93***	1.38***	± 2.0***

\* If these values (and their corresponding calculated values\*\*) are discarded using Goodwin's Test, values \*\*\* become  $\pm .0001$ ,  $\pm .0002$ ; 0.47%, 0.93%; 1318;  $\pm 17$  lbs.; and 1.3% respectively.

<sup>1</sup> Wgt. Al, tapped, plus that dug from lining, 1335 lbs.

TABLE 7. Effectiveness of method in estimating the inventory of aluminum in 10,500 amp cells

Cell	No. of samples taken when cell was shut down	Time between addition of Cu and shutdown, hrs	Wt. of Al calculated from the analysis for Cu, lbs	Wt. of Al tapped & dug, lbs	Limitation of method for calculating inventory of Al, % of metal (relative error)
1	8	24	1308	1335	-2.0
2	2	5	970.3	984.5	-1.4
3	2	5	940.5	946.5	-0.6
4	8	24	989	1070	-7.6
Average:					-2.9

would be 1.3 percent. This is lower than the 1.8 percent accuracy Snell and Snell (8) list for the diethyldithiocarbamate method.

A further indication of the accuracy of this method is provided in Table 7. The comparison of the production of aluminum calculated from the analytical values with the production measured by weighing is extended in this Table to include the next three cells tested with this technique. The average error of the predictions of inventory for three of four cells was 1.3 percent. This is less than the 2 percent prediction of inventory that was initially requested. The average error of predicting inventory with this method for all four cells was 2.9 percent.

### SUMMARY

In conclusion, the author believes that Reduction Research Laboratory has been successful in contributing improvements to published methods for the determination of copper in aluminum using diethyldithiocarbamate. The precision and accuracy of this method are indicated to be equal to, or better than, quantitative analyses. The acid solutions of the standards and samples are stable for several months.

The precision of Reduction Research's method in application ranged between standard deviations of  $\pm 0.0000$  to  $\pm 0.0003$  percent for the range encountered using the dilution technique, 0.0019 to 0.0304 percent Cu, based on the analyses of from two to eight samples taken from a cell at the same time, half being taken from each side.

It was not always possible to determine the accuracy of this method for the reasons given, but the indicated accuracy, 1.3 percent, obtained by comparison of the reserve of aluminum calculated with the weight of aluminum recovered from three out of the four cells, met, and the average for all four cells, 2.9 percent, approached, the objective of predicting the reserve aluminum inventory within 2 percent.

### ACKNOWLEDGEMENTS

The author thanks Mr. Robert M. Kibby, General Director of Reduction Research, for assigning him the development of this method; Mr. Kibby and Reynolds Metals Company for permission to publish this information; and all

the members of Reduction Research who helped with consultation, analyses, application of the method, editing, and publishing the report.

#### REFERENCES

1. British Aluminum Company, Limited 1961. Analysis of Aluminum and Its Alloys, No. 405, Norfolk House, St. James's Square, London SW 1, p. 166.
2. Chemical Abstracts. 1953. 47, 8579.
3. Furman, N. H. 1962. Scott's Standard Methods of Chemical Analysis. Vol. I, 6th Edition, D. Van Nostrand Co., Inc., New York, p. 407.
4. Goodwin. 1920. Precision of Measurements and Graphical Methods. McGraw Hill Book Co., Inc., New York, New York, p. 20.
5. Pohl (460). 1955. Anal. Chim. Acta, 12; 54-63. As cited by Welcher (9).
6. Sandell, E. B. 1950. Colorimetric Determination of Traces of Metals. 2nd Ed. Rev., pp. 304, 305.
7. Smart, R. 1963. The Determination of Aluminum Reduction Cell Current Efficiencies by Very Small Copper Additions. Extractive Metallurgy of Aluminum, Vol. 2, Interscience Publishers, New York, New York, pp. 249-259.
8. Snell, F. D. and Snell, C. T. 1954. Colorimetric Methods of Analysis. D. Van Nostrand Co., Inc., Vol. II, Third Edition, pp. 78-80 and 107-111.
9. Welcher, F. J. 1958. The Analytical Uses of EDTA. D. Van Nostrand Co., Inc., New York, pp. 209-291.



# The Design And Performance Of A Mössbauer Effect Spectrometer<sup>1</sup>

I. F. Rushton<sup>2</sup>

Physics Department  
University of Alabama, University

## INTRODUCTION

The Mössbauer Effect is the recoil-free emission and resonant absorption of gamma rays (4, 5). The effect is an extremely valuable research tool because it provides the most accurately defined electro-magnetic radiation available for physical experiments. It can therefore be used to obtain a better understanding of some properties of matter, such as nuclear structure, chemical bonding, nuclear quadrupole and magnetic moments, and also the internal electric and magnetic fields in crystalline solid. Some applications to problems in lattice dynamics have also been made.

In a free atomic or nuclear system of mass  $M$  with two levels A and B separated by an energy  $E_0$ , the atom or nucleus de-excites from B to A by emission of a photon of energy  $E$ . Momentum and energy considerations lead to the relation

$$E_0 - E = R - \frac{EV_x}{c} \quad [1]$$

$R$  represents the free-atom recoil energy;  $c$  is the velocity of light. The system velocity,  $V_x$ , results from the inherent thermal energy of the system and represents the Doppler effect. Equation [1] holds for the case where the emission of the gamma ray has been assumed in the  $x$ -direction.

Equation [1] states the fundamental condition of gamma emission by an excited freely recoiling nucleus decaying from level B to A. If, however, the excited nucleus is bound in a crystalline lattice, it cannot recoil freely and the recoil momentum is taken up by the whole crystal. This fact becomes particularly important when the free atom recoil energy is comparable to the energies of lattice vibrations.

Under certain circumstances there is a finite probability of a gamma ray being emitted without any phonon emission or absorption. This is known as the "zero-phonon" process. In these processes no energy is transferred to the lattice, and the gamma ray then possesses the full energy of the transition. There is no effective recoil of the nucleus—the recoil energy is taken up by the center of mass of the entire bulk solid. The emitted gamma rays with no phonon excitation then have the proper energy to be resonantly absorbed or scattered in an analogous zero-phonon process.

Mössbauer experiments are performed using a radionuclide source that provides zero-phonon gamma emission, and an appropriate resonant absorber. Due to the high selectivity of the absorber, of the incident radiation only the unshifted "Mössbauer line" — the spectral line that is not subject to Doppler

<sup>1</sup> Submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Physics of the Univ. of Ala.

<sup>2</sup> Present Address: Department of Mathematics and Engineering, Prince George's Community College, Largo, Maryland.

broadening — is resonantly absorbed. In this unshifted line both nuclear recoil and Doppler broadening have been effectively eliminated.

The aim of this paper is to describe the design, fabrication, and calibration of a Mössbauer effect spectrometer that was built in the Physics Department of the University of Alabama.

A period of approximately a year and a half was spent in designing and building the spectrometer. As the work progressed, tests were performed to estimate the effectiveness of different component combinations so as to determine the most efficient final assembly. The radionuclide source employed for calibration was  $^{57}\text{Co}$  deposited in copper lattice. A stainless steel absorber was used to produce a single line resonance spectrum. The other absorber used was natural iron which split the single line Mössbauer spectrum into a hyperfine pattern and was used for calibration of the energy scale as well as for determination of the resolution of the instrument.

### METHOD OF MEASUREMENT

A Mössbauer effect experiment is conducted by using the ordinary, or first order, Doppler shift. This is done by introducing a mechanical motion between the source and the absorber. This motion achieves a modulation of the energy of the gamma ray. The experiment is completed by measuring the number of gamma photons transmitted through the absorber as a function of the relative velocity between the absorber and the source.

The unshifted spectral line studied in Mössbauer experiments is not subject to either nuclear recoil or Doppler broadening. The mechanical motion just discussed restores the Doppler velocity term of equation [1] to the process of emission or absorption. We can write

$$E_o - E = \frac{EV_x}{c} \quad [2]$$

Equation [2] states the fundamental process for conducting a Mössbauer effect experiment. By varying  $V_x$ , an energy search over the range of energies adjacent to the unmodulated photon energy  $E_o (V_x=0)$  can be carried out and a Mössbauer effect spectrum obtained.

### DESIGN OF THE TRANSDUCER

Two categories of velocity drives are in general use: constant velocity drives in which the number of gamma photons transmitted through the absorber are detected over a length of time at a constant velocity and the velocity is changed in step (4), and variable velocity drives in which either the source or the absorber is put into oscillation and the number of gamma photons transmitted is measured as a function of instantaneous velocity (7). Each method has advantages for certain types of investigations. In either case, data from positive and negative velocities of equal magnitude should not be lumped together without ascertaining that the velocity (energy) spectrum is symmetric with respect to the zero velocity. The usual convention is to take velocities as positive when the absorber approaches the source.

Equation [2] makes it clear why the mechanical motion, essential to a Mössbauer effect experiment, must be characterized by precisely controlled velocities. Since the energy shift is a linear function of velocity, the slightest



vibrations originating either in the velocity drive mechanism itself or from the environment of the spectrometer will change the energy shift in an unknown way, and thus the measured Mössbauer spectrum has no reliability. This condition demands a transducer whose linear velocities are always known with precision. The recent technical improvements in the design of transducers have been reviewed by several authors (3).

## DESIGN OF THE SPECTROMETER

The spectrometer was designed so that the Mössbauer source and the absorber could be kept at the same low temperature either that of liquid nitrogen or liquid helium. The complete configuration of the designed spectrometer for use with the source and absorber at liquid nitrogen temperature is shown in Figure 1.

An electromechanical variable velocity transducer was used. This transducer is shown in detail in Figure 2. Two permanent Jensen loud-speaker magnets were mounted back to back, i.e., the south poles of the magnets faced each other across the internal gap and were clamped together by an aluminum ring. A hollow brass cylinder, or sleeve, passed through the common axis of the magnets. This cylinder had an outside diameter of 1 in. To accommodate this cylinder, a central hole of  $1\frac{1}{8}$  in. diameter was drilled through the two magnets, allowing an approximate 1/16 in. radial clearance between the magnets and the wall of the cylinder. Three equally spaced brass set-screws were positioned in the upper and lower bakelite collars and fitted against the brass cylinder. These set-screws were for the purpose of giving fine adjustment to the vertical alignment of the cylinder. Two voice coils attached rigidly to the cylinder with epoxy were free to move together axially in the gaps of the magnets. A sinusoidal signal from a low frequency function generator was fed to one coil which oscillated the cylinder, and the other coil developed an emf (the "velocity signal") proportional to the velocity.

In this arrangement, the Doppler velocity was applied to the absorber which was mounted at the end of a 20 in. hollow thin-wall stainless steel tube which passed through the brass cylinder mentioned earlier and rested on top of it. The teflon bushing secured the tube and prevented internal vibration. The stainless tube-brass cylinder-bakelite collar assembly was suspended in its position inside the magnets by means of two phosphor-bronze springs, or "spiders". The two springs were attached to the upper and lower bakelite collars. Each spring had four equally spaced legs, and was secured to the magnet assembly with brass screws as shown in Figure 2.

The Mössbauer source was placed in a brass source holder and secured with a screw clamp. A  $0.9 \text{ mg/cm}^2$  thick mylar foil was clamped down over the source to seal it.

Since the source was kept cold, the tube in which the source holder was placed was made of a long stainless tube of 0.010 in. wall thickness and  $\frac{7}{8}$  in. diameter to prevent rapid boil-off of the liquid air. The source holder fitted into the tube with a total diametric clearance of 1/16 in. This clearance allowed easy removal of the holder, yet achieved snug enough fit to insure centering of source in the tube. The internal screw threads of the source holder which held the screw clamp also served another purpose. A long,  $\frac{5}{8}$  in. diameter solid aluminum rod, threaded at the end, could be inserted into the threads of the holder and then turned enough to engage the threads.

The source holder could thus be lifted out of the tube when removal of the source from the spectrometer was desired. The tube carrying the absorber previously described had a wall thickness of 0.010 in. and was of  $\frac{5}{8}$  in. diameter. There was an approximate clearance of  $\frac{3}{4}$  in. between the source and the absorber. The system comprising the electromechanical transducer was enclosed in an aluminum chamber which was sealed with an O-ring to a heavy stainless steel plate with a hole in the center. The tube carrying the Mössbauer source was welded to the edge of the central hole of the plate. This whole system could be evacuated with a vacuum pump (Figure 1). For use at liquid nitrogen temperature, a stainless steel dewar was used which was not a part of the vacuum system. When the dewar was

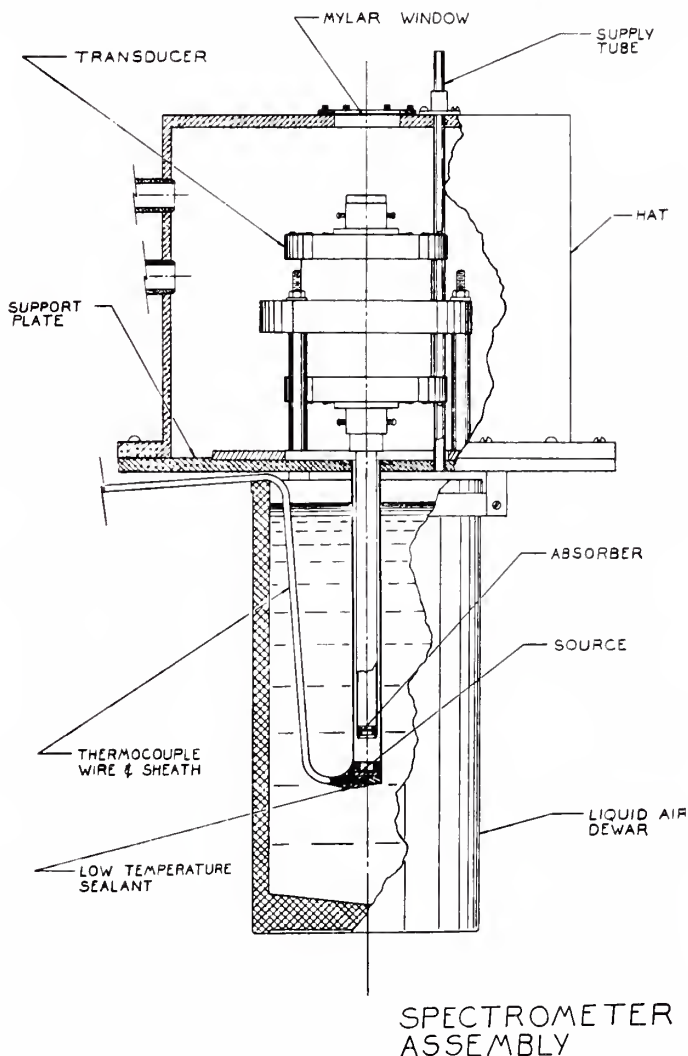


FIGURE 1. Mössbauer effect spectrometer assembly.

completely full of liquid nitrogen, the source was positioned approximately 9 in. below the liquid nitrogen level.

The temperature of the source was ascertained with a constantan-copper thermocouple. The thermocouple made contact with the bottom of the brass source holder through a small diameter hole drilled through the base of the tube carrying the source. The lead wires of the thermocouple were shielded from the liquid nitrogen by a length of  $\frac{3}{8}$  in. diameter stainless steel tubing. This tubing was soldered to the bottom of the source tube and sealed with a low temperature synthetic rubber compound.

The system was maintained at about 30  $\mu$  of Hg pressure during the experimental runs. This was done primarily to prevent the formation of ice on the source at liquid air temperature. Silica-jel desiccant was also placed inside the "hat" during runs to help prevent moisture formation.

The spectrometer assembly was supported by a rectangular frame made from aluminum angle sections. This frame in turn rested on a U-shaped pedestal constructed from blocks of concrete. In order to insulate the spectrometer from environmental vibrations, a 1 in. thick beaverboard pad was

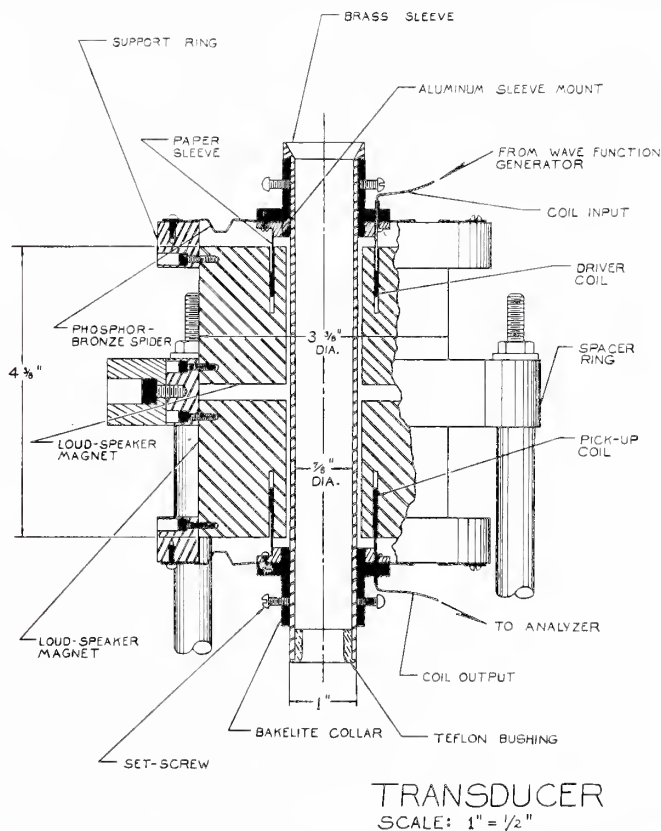


FIGURE 2. Details of the Electromechanical Transducer using two Jensen loud-speaker magnets back to back. The stainless steel rod carrying the absorber passes through the central hole.

placed between the concrete pedestal and the floor of the room. However, the output signal from the transducer revealed that activities in the neighboring rooms affected the transducer motion. In an effort to correct this, 4 in. thick lengths of foam rubber were placed directly under the frame supporting the spectrometer. The foam rubber was then loaded with lead blocks and compressed to about  $\frac{3}{4}$  in. to give stability. This shock-mounted the transducer with a fair degree of success.

The major part of the spectrometer components was fabricated in the Physics Department machine shop.

The gamma ray detector was placed over a 0.075 in. thick mylar window on top of the vacuum tank. This mylar window was centered over the transducer axis, which vertically aligned it with both absorber and source.

As indicated in Figure 1, the designated spectrometer is for study of the Mössbauer effect at liquid nitrogen temperature. For use at liquid helium temperature only a slight modification was needed. In this work the transducer, source, and absorber were all placed inside the vacuum system comprising of a liquid helium dewar with the aluminium vacuum tank on top. A large stainless dewar containing liquid air was used as an outer jacket to the helium dewar. Arrangements were made for recovering the evaporated helium gas.

The spectrometer was calibrated at liquid air temperature observing the Mössbauer effect of the 14.4 keV gamma ray in  $^{57}\text{Fe}$ . The Debye-Waller factor of this transition (6) is known to be very high at this temperature and little is gained by further reduction of temperature.

## MÖSSBAUER SOURCE AND ABSORBERS

The radionuclide source employed in this experiment was  $^{57}\text{Co}$  doped in copper host lattice. The decay scheme of  $^{57}\text{Co}$  is well known (8). This isotope has a half-life of 267 days, and decays into  $^{57}\text{Fe}$ . Resonant absorption of the 14.4 keV gamma ray can be achieved in an absorber containing stable  $^{57}\text{Fe}$ .

Two types of absorbers were used during the calibration runs, one of stainless steel and the other of natural iron. Since natural iron has an internal magnetic field it produces Zeeman splitting of the nuclear energy levels and so provides a Mössbauer spectrum with hyper-fine splitting. The stainless steel absorber has no internal magnetic field and therefore provides single line absorption at room temperature as well as at liquid nitrogen temperature. This lattice has cubical symmetry and therefore there is no electrical field gradient at the lattice site also.

In natural iron, the magnetic hyperfine splitting of the ground and the first excited states may be schematized as shown in Figure 3. The 14.4 keV gamma radiation is almost entirely magnetic dipole in character with a slight admixture of E2. This requires that the transitions be accompanied by no change in parity, and follow a selection rule of  $\Delta m = 0, \pm 1$ .

## EXPERIMENTAL ARRANGEMENT

The usual configuration for Mössbauer experiments contains four basic elements. They are source, absorber, transducer, and a detector for the gamma rays. The detector used was a model no. RSG-30A proportional

counter manufactured by Reuter-Stokes. It was designed to detect X- and gamma radiation from 3 to 100 keV range. Features included a beryllium side window. The counter was filled with a gas mixture of xenon-methane to one atmosphere pressure.

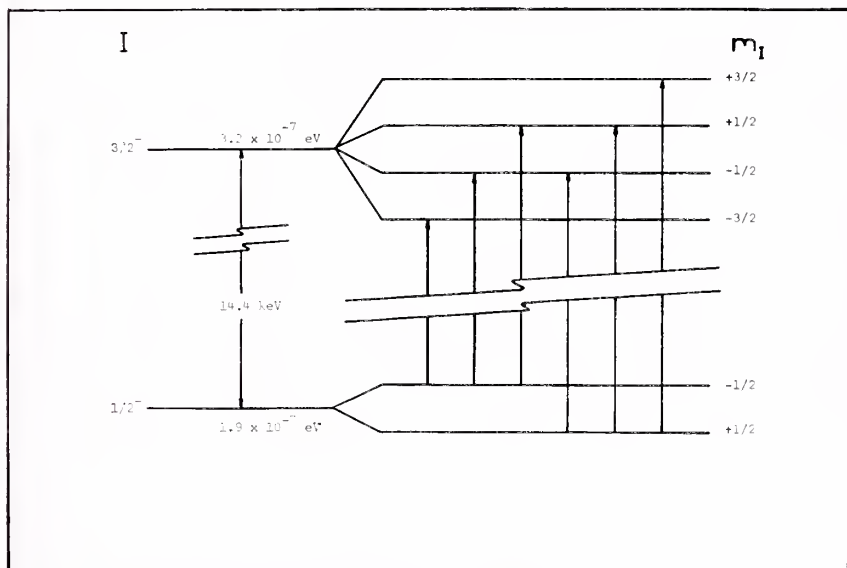


FIGURE 3 Splitting of the ground and first excited states of  $^{57}\text{Fe}$  nucleus due to the internal magnetic field in iron absorber.

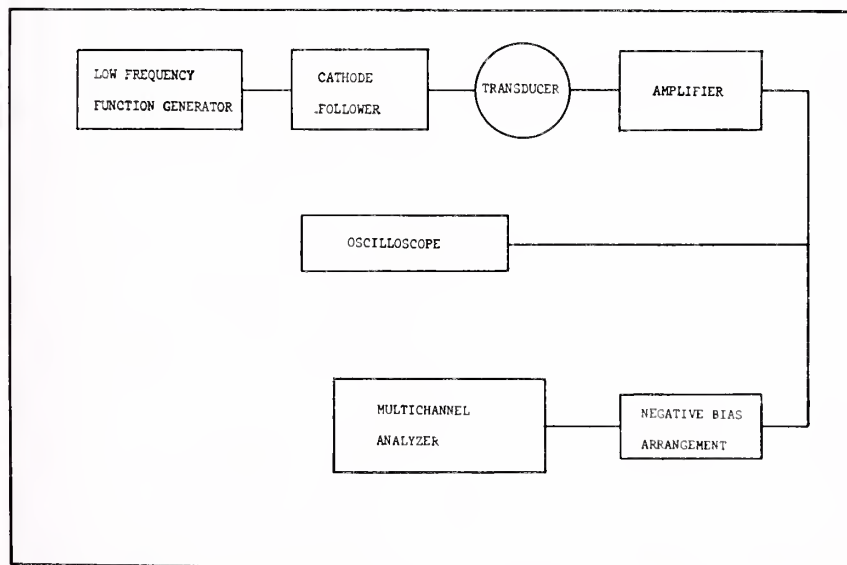


FIGURE 4. Block diagram of the electromechanical transducer arrangement.

The pulses from the preamplifier were fed to a Baird Atomic Model 215 Linear Amplifier and then directly to a 400 channel RCL Pulse Height Analyzer. The counter was operated at 2000 V.

In this experiment, sinusoidal motion for the absorber was decided upon because of the ease with which this motion could be obtained. The sinusoidal input to the transducer was provided by a Hewlett Packard Model 202A Low Frequency Function Generator. A cathode follower was built to match the impedance between the function generator and the loudspeaker coils. The frequency was adjusted very close to the natural frequency of the transducer, which was approximately 27 cycles/sec. The velocity signal derived from the transducer pick-up coil was amplified by an amplifier and the amplified signal was fed to the multichannel analyzer as indicated in Figure 4. Since the analyzer required a signal between 0 to -5 volts, a proper biasing arrangement was provided. The output of the pick-up coil of the transducer was used to control the memory location in the multichannel analyzer. The velocity signal modulated the counts from the gamma ray detector and the counts were stored in the analyzer memory as a function of the instantaneous velocity of the transducer.

Since sinusoidal motion means variable acceleration, the plot of the number of recorded counts as a function of velocity displays a parabolic spectral shape, with zero velocity at the mid-point of the pattern. Experimental curves obtained in this manner were "normalized" by recording the same curve utilizing gamma rays which were NOT resonantly absorbed. The second group of counts could be considered a "back ground" curve. By dividing the first spectrum by the back ground spectrum, we got the true Mössbauer effect spectrum with proper correction for the unequal time spent in each channel due to the inherent property of the sinusoidal motion.

The  $^{57}\text{Co}$  radiation spectrum as detected by the proportional counter

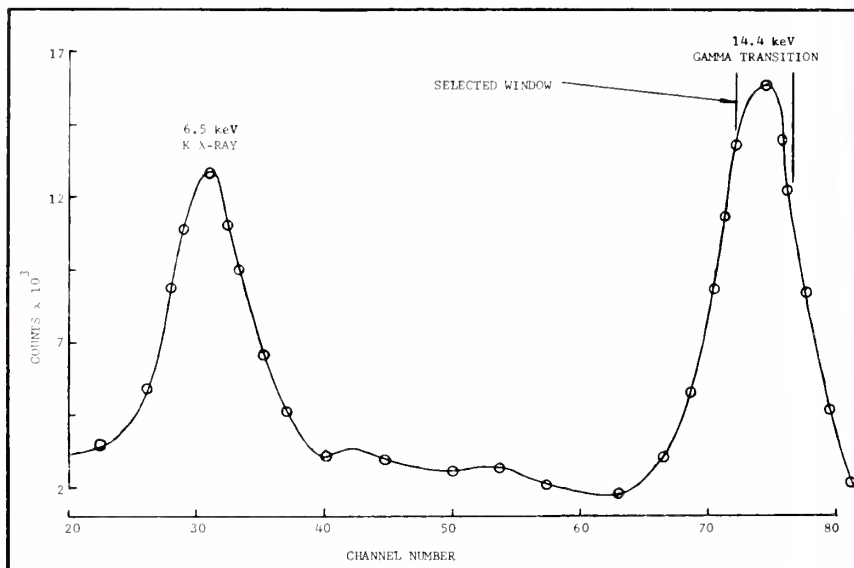


FIGURE 5. Low energy radiation spectrum of  $^{57}\text{Co}$ .



showed prominent energy peaks which are a 6.4 keV iron K X-ray peak resulting from orbital electron capture and internal conversion and a 14.4 keV peak due to the gamma transition of that energy, and is shown in Figure 5.

### MÖSSBAUER EFFECT SPECTRUM MEASUREMENT FOR CALIBRATION

A part of the 14.4 keV gamma peak was selected using a single channel analyzer and the output of this analyzer was used to gate the 400 channel pulse height analyzer. The velocity signal derived from the pick-up coil was fed to the "Mössbauer input" of the analyzer and the analyzer re-

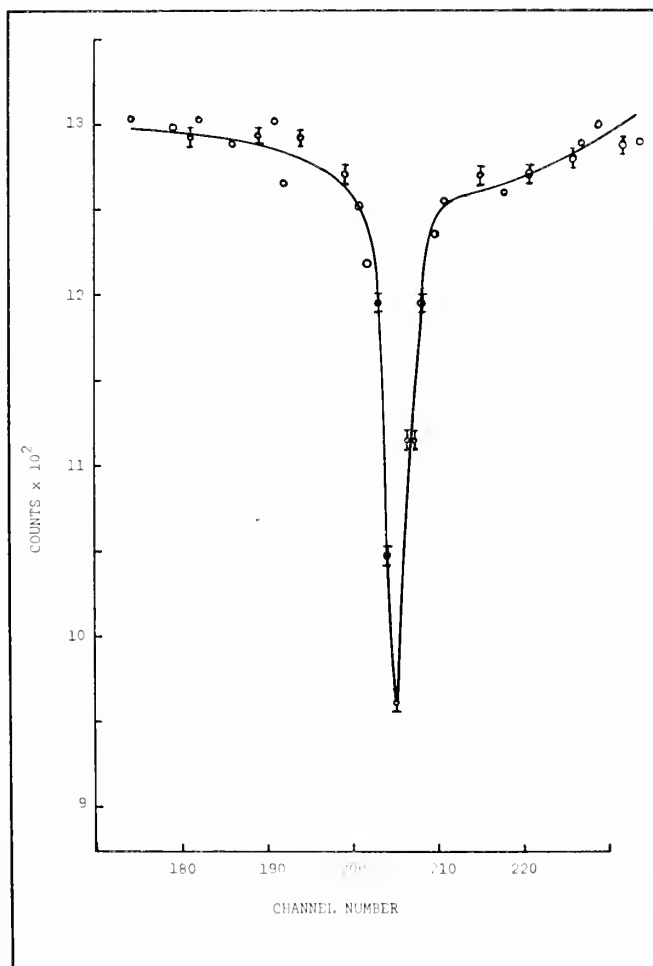


FIGURE 6. Normalized Mössbauer spectrum taken using  $^{57}\text{Co}$  in copper host lattice and 1 mil thick stainless steel absorber. Both the source and absorber were maintained at liquid air temperature.

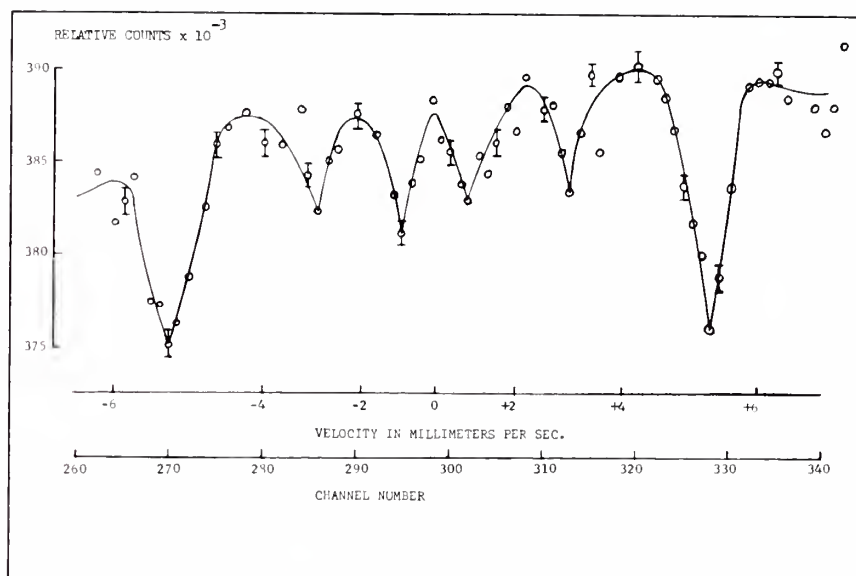


FIGURE 7. Normalized Mössbauer spectrum taken using  $^{67}\text{Co}$  in copper host lattice and 1 mil thick iron absorber. Both the source and the absorber were kept at room temperature.

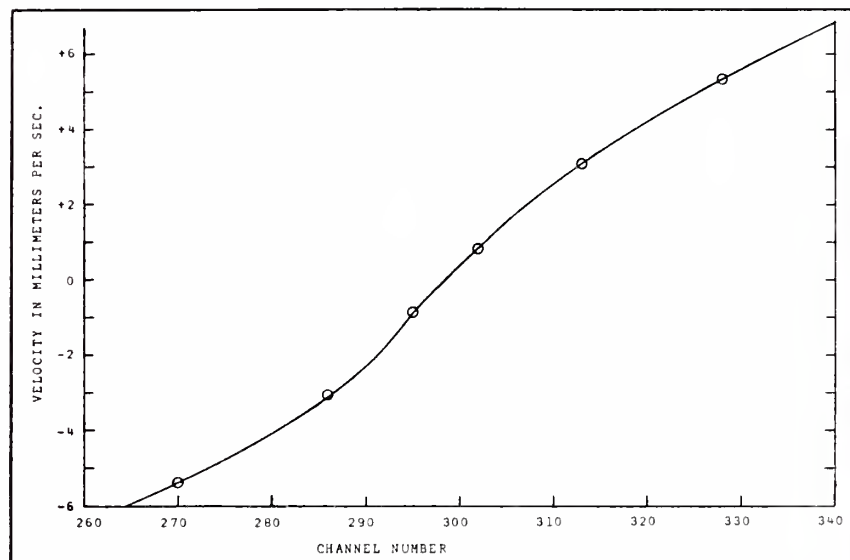


FIGURE 8. Calibration of the velocity scale of the spectrometer using the known energies of the six resonant absorption lines in iron absorber of a  $^{67}\text{Co}$  source in copper host lattice.



corded the counting rate as a function of velocity. The recorded Mössbauer spectrum was "normalized" in each case by repeating the procedure after having replaced the Mössbauer source by a source which was known to have no recoilless transition and then dividing the first set of data by the second. Runs were made with the  $^{57}\text{Co}$  source in copper host lattice and absorbers made of stainless steel and natural iron. These absorbers have been described earlier.

The source and the absorber were both kept at liquid air temperature in the case of the stainless steel absorber. In the case of the iron absorber data were taken both at liquid air temperature and at room temperature. The normalized spectra are shown in Figures 6 and 7. The half-width of the absorption line (I) in Figure 6 is related to the lifetime  $\tau$  of the 14.4 keV excited state of  $^{57}\text{Fe}$  through the relation

$$\tau I = h$$

Correction factors due to finite source and absorber thickness are to be employed (2) to obtain the true value of the lifetime  $\tau$  which is known. Since the correction factors are rather uncertain, these data were not used to calibrate the velocity scale of the Mössbauer spectrometer.

The spectrum taken using natural iron absorber and  $^{57}\text{Co}$  source in copper lattice shows six absorption lines due to splitting of the ground and excited states of  $^{57}\text{Fe}$  by the internal magnetic field in iron (Figure 7). These absorption lines are well separated showing that the spectrometer built is capable of required resolution needed to perform studies of complicated Mössbauer effect spectra. The Doppler velocities associated with the six peaks in Figure 7 are well known (1) and therefore, the positions of these peaks were used to calibrate the velocity scale of the spectrometer and the calibration curve is given in Figure 8. There is a slight nonlinearity in the transducer system for higher velocities but in the lower velocity region the linearity of the system is satisfactory.

### ACKNOWLEDGEMENTS

The author is indebted to Professor Ambuj Mukerji for suggesting the problem, for the preliminary design of the spectrometer, and for many discussions. Help rendered by Mr. M. Milo McEllhiney of the Physics Department Machine Shop in the design and fabrication of the spectrometer is gratefully acknowledged. Thanks are also due to Drs. R. N. Whitehurst and F. H. Mitchell for help with the electronic system.

### LITERATURE CITED

1. Dash, J. G., R. D. Taylor, O. E. Nagle, P. O. Craig and W. M. Visscher. 1961. Phys. Rev. 122: 1116.
2. Margules, S., and J. R. Ehrman. 1961. Nucl. Instr. and Methods 12: 131.
3. Mössbauer Effect Methodology. 1965. Vol. I. I. J. Gruverman (ed.), Plenum Press, New York.
4. Mössbauer, R. L. 1958. Die Naturwissenschaften 45: 538.
5. Mössbauer, R. L. 1958. Zeitschrift f. Physik 151: 124.
6. Mukerji, A. 1966. The Mössbauer Effect, Technical Report No. RR-TR-66-5 U.S. Army Missile Command, Redstone Arsenal, Ala. (Unpublished)
7. Ruby S. L., L. M. Epstein and K. H. Sun. 1960. Rev. Sci. Instr. 31: 580.
8. Sprouse, G. D. and S. S. Hanna. 1965. Nuclear Physics 74: 177.

## Capital Budgeting In Local Government

Robert J. Juster  
Regional Planning Commission  
Birmingham, Alabama

The purpose of government is to provide a stable and stimulating setting for social and economic activities. Government has also assumed the responsibility for supporting services which are essential for community development but cannot be furnished by private enterprise. Today, through its municipalities, counties, and their related agencies, local government offers a broad and dynamic range of services including protection, education, recreation, transportation, health, welfare, and utilities.

These services require the major outlay of public funds for equipment, facilities, land and structures. Between 1958 and 1965 capital expenditures of local governments in the U.S. increased from \$8 to almost \$12 billion. Extensive studies recently completed for the Joint Economic Committee of Congress estimated that capital outlays of municipal public agencies alone between 1966 and 1975 would range between \$169 and 201 billion. An annual average of one-fifth of total local government expenditures is anticipated for capital items.

### IMPORTANCE OF CAPITAL OUTLAYS

Local government capital outlays are not only important financially. They also have considerable strategic value because public facilities are not passive partners in community development; they can have a significant influence on the amount, direction, and rate of growth of an urban area. For example, the construction of a new major highway through a previously inaccessible area may well raise land values within its vicinity and spur the development of an industrial or residential area and substantially change the growth pattern of a community.

Probably of more immediate concern to local officials is the fact that most urban areas are facing a tremendous backlog of demand for public services which has been further aggravated by the accelerated population and economic growth of the post-war period.

### PURPOSE OF CAPITAL BUDGETING

Many conflicting demands are competing for a limited amount of funds. In the private sector, one method of coping with this problem of allocating scarce resources and committing funds to long term purposes is capital budgeting. Capital budgeting is designed to answer three questions: how much money will be needed for capital outlays during the planning period; how much money is likely to be available; and, how will available funds be assigned to competing projects. These questions must be resolved whether the budget is for a private firm or a public agency, and whether or not systematic methods are used.

It is very difficult to determine the extensiveness of capital budgeting techniques among local governments. Studies by the International City Managers Association showed that in 1957 only 25 percent of reporting cities had a capital budget in effect. Even though the number has probably in-

creased it is apparent that such budgeting is still not a widespread technique.

In view of the importance of capital outlays of local governments the question arises as to why their programming is not more prevalent. For both the public and the private sectors, the assignment of priorities is the key question. In the private sector it involves the relative profitability of competing projects; in the public sector the question cannot be posed in such precise terms. In addition, the changes and pressures which are rampant in urban areas have a direct bearing on public fiscal operations and they create complex conditions for the governments concerned.

### POPULATION CHANGES

At present, about two-thirds of the population of the country live in urban areas; within 10 years, about 75 percent of the population will be urban. In the past 15 years the greatest gains in urban population have been in the school age groups and in those over 65 years of age. These are segments of the population which create a very high demand for public facilities and services thereby adding to the burdens of local government.

Within urban areas there has been a movement of population which also has had an impact on services and demands for local government. Within the 212 Standard Metropolitan Statistical Areas defined by the Bureau of the Census in 1960, the central cities gained only 12 percent in population between 1950 and 1960; whereas the suburban areas increased by 46 percent. In many urban areas there has been a substantial migration from the central cities to the outlying suburbs, typically of white, middle and upper income families; their place in the central city has been taken by lower income families. Thus, the older cities which contain obsolete and decaying portions of the urban area and whose property tax base is being eroded, are housing more low-income low-skill families, and are plagued with the attendant problems of unemployment, poverty, crime, and disease. All of these add to costs and the demands for services.

Concurrently, suburban areas frequently have been submerged by a tidal wave of residential growth which has added tremendously to the demands for schools, sewers, and utilities. As the outward spread continues, people are living further from their place of work and daily commuting travel becomes longer and more complicated, creating additional strains on the urban transportation system and adding to the demand for improved and expanded facilities.

A further recent change has been the rise in family income and living standards which has also affected demands for public services. Although he is not always willing to pay for it, the average urban dweller today demands a very high level of education for his children and a high level of other public services such as streets, sewers and utilities. This is emphasized by the fact that between 1956 and 1966 the U.S. population increased by 16.5 percent, but the per capita expenditure of state and local governments for purchases of goods and services on a constant dollar basis rose by 44 percent. This disproportionate increase in per capita purchases was mainly the result of greatly increased demands for more public services and their provision at a higher level of quality, a reflection of the general increase in living standards and attitudes.

## REVENUE LIMITATIONS

The growing demand for services requires relentless increases in revenue. Revenue problems are constant and complicated because local governments have a restricted range of tax sources which are further subject to a number of limitations.

Because population and economic activities are highly mobile, both within and among urban areas, individual localities must give a great deal of consideration to matters of equity in seeking and using tax sources. They cannot impose a tax within their own jurisdiction which is substantially different from that of adjoining areas. For small units of local government problems of collection, administration, and policing of tax sources can become difficult and costly; and may in some cases discourage them from utilizing certain types of tax.

Perhaps the most severe limitation is that imposed by the fact that most local governments are creatures of the state and by the terms of their creation their sources and opportunities for tax revenue are frequently restricted. Many have inherited rigid taxing structures which are not geared to their present needs, but are difficult to change. In many cases their ability to incur long term debt is limited by charter provisions. Their biggest source of revenue has generally been the property tax; to cope with growing demands they have had to exploit this to the fullest. However, it is felt that in many cases they are approaching the limit in relation to this source of revenue; and again in view of urban mobility the possibility of restricting further growth or perhaps losing existing industry and population may be quite real if property tax rates get too high.

Local governments are also at some disadvantage in taxing ability in relation to federal and state governments. The federal government has preempted the field of income tax and in recent years the states have also entered this field. Similarly the states have preempted the field of sales tax revenue. It is true that in many urban areas, both income and sales taxes are imposed. However, where this occurs they are super-imposed on the federal and state taxes of the same source and this must be done with great care to avoid creating an undue burden on the individual tax payers and perhaps also adding to the tendency to slow or discourage growth.

## GOVERNMENT FRAGMENTATION

The increase in population and urban areas has been accompanied by the growth of local government units and jurisdictions. These new units have been created for a number of reasons including: the need to provide urban services to rapidly developing areas, the desire on the part of a particular area to avoid being annexed or incorporated into an adjoining city, and in an attempt to deal with a particular problem existing within the urban area. The net result has been to create a multitude of local jurisdictions and agencies with a considerable amount of overlapping of authority and service areas.

For example, in 1960 the 212 Standard Metropolitan Statistical Areas contained about 17,000 local government units. These included counties, municipalities, school districts, utility districts, and many other special authorities and districts. This fragmentation of urban areas has a big impact on local government fiscal operations because it frequently creates extreme



disparities between the area from which revenue is derived and that for which service is provided.

It is now the rule rather than the exception to find that a family may live in an independent suburban community, have members working in the central city, educate its children in one of many school districts, use shopping or recreational facilities in other communities in the urban area, obtain water from one utility and power from another, and use the entire street system within the metropolitan area regardless of where political boundaries occur.

The greater the number of separate jurisdictions within an urban area the more difficult it becomes to derive a direct relationship between those who use and those who pay for services. Many services such as water supply, sewage disposal, and transportation must have large service areas to function efficiently and economically. Even services for which the limits of the area can be fairly well defined, such as police and fire protection, education and health, do not benefit from multiplicity and fragmentation of jurisdiction since the areas are too small to provide an effective service.

This fragmentation also has implications in terms of municipal revenues, particularly those which are derived from property tax sources. Commercial and industrial uses, which generate the highest tax return in relation to the services they demand, are not uniformly distributed throughout the urban area. A community may find that it has very little non-residential property to help generate tax revenue but is facing a heavy demand for municipal services from residential areas. At the other extreme, a community may have an extensive and wealthy industrial operation which it uses as a means of financing its activities, and it can do this at a much higher level of quality than other jurisdictions within the same area. This factor has a particularly unfavorable impact upon the central city which is experiencing the greatest amount of obsolescence and removal of property from the tax rolls for public purposes. It also aggravates the problems of disproportionate demand which are created within the city by the outflow of wealthy and the inflow of lower income households.

Urban government can best be characterized as organized chaos, and it compounds the confusion by encouraging complex and widely differentiated tax structures; fostering an imbalance between the supply of and demand for services and facilities; complicating and inhibiting the abilities of individual units to tap adequate sources of revenue; and making it difficult to achieve the coordination and cooperation which ultimately are essential if operating economies are to be gained in the provision of public services.

### FEDERAL PROGRAM PROBLEMS

As the problems of financing local operations and services have increased, local governments have turned more to federal sources for revenue, and Congress has been responsive to their needs. The federal grant-in-aid, which is an allocation of funds for a specific purpose under certain conditions, has been a useful device and has had a major impact in urban areas, but this has not occurred entirely without problems.

A major drawback has been the proliferation of programs which has accompanied the increase in funds. The 116 categories of grants listed by the Legislative Reference Service of the Library of Congress in 1964 had increased to 162 in 1966. In many instances, completely new agencies or

new subdivisions of existing agencies have been created to handle these new grants, and each of the multitude of programs, agencies, and departments has different procedures, standards, financing formulae and channels of distribution. There has been direct conflict among some of the programs and between some programs and local objectives; the net result has been a tremendous increase in the complexity of obtaining, administering, and accounting for these federal funds.

Apart from the administrative complications, the fact that the funds provide leverage for local governments has also been viewed adversely. Under many of these federal programs, local dollars can be used to match federal money on a 2, 3 or even higher basis, and some programs have added financial incentives. For the local official who finds himself faced with rising demands and limited revenue, there is a strong temptation to use every available federal source and thereby to overemphasize the services and facilities for which federal funds can be obtained. While this enables local dollars to be stretched further, it does not necessarily mean that actual needs are evaluated objectively or that the most critical are given priority.

### THE POLITICAL FRAMEWORK

Underlying all questions of local government finances and services is the fact that all decisions are undertaken within a political framework. No matter how equitable the revenue and income distribution and tax structure; no matter how sound or thorough the fiscal analysis; it is likely that the ultimate decision concerning a project will be made on the basis of such considerations as where the expenditures might generate the greatest number of votes; where the greatest public pressure is being exerted; or which will enhance a reputation or have voting appeal. This sometimes, although not always, conflicts with findings based purely on needs or benefits.

It is for this reason that elected officials are often reluctant to engage in capital budgeting. If budgeting of capital outlays is done properly it implies, and requires, an annual commitment to the outlay of funds for specific projects. Many elected officials prefer to have more flexibility in the use of funds so that they can adjust such outlays in response to pressure or political opportunities.

It is also true that the multiplicity of urban governments tends to aggravate the impact of political factors on public financing decisions. For many public functions such as transportation or land use planning, it has become recognized that coordination is essential and interjurisdictional agencies have been created for this purpose. Most analyses of metropolitan operations would support the contention that coordination is also needed for fiscal planning. Local government officials and administrators are generally sensitive on questions of financing, and the multiplicity of jurisdictions increases the possibilities for friction and makes the task of coordination and cooperation extremely complicated and difficult.

### SIGNS OF CHANGE

I have up to this point emphasized the negative aspects of the situation—that relatively few cities have effective capital budgeting methods in force; and that substantial problems will be encountered in developing and

implementing an effective budgeting system. However, several factors appear to be moving local governments toward more positive and promising methods.

One of the biggest factors is the nature of the problems which beset local governments. Looking to the future these problems appear to be getting bigger but not better, and as their scale and complexity increase local administrators will be forced to seek more effective methods and programs. Ultimately all the problems are reduced to matters of expenditure and revenue and it seems inevitable that capital budgeting will have to become more widespread if adequate solutions are to be found.

Concern for the problems of local government is now widespread. In the last five years, under the generic heading "The Urban Problem", they have become a major topic of research and discussion. This is creating a climate which is not merely receptive to, but is emphasizing the great need for, new ideas and techniques of public administration. In this context capital budgeting, which has already gained a foothold, should expand considerably in actual application in the near future.

It is highly significant that within the last two years the business community has become extremely active in the national dialogue on urban problems. This is not merely a belated acceptance of a share in the responsibility for urban affairs, but also a recognition of the fact that the efficiency and quality of a metropolitan area are very much a part of the cost of doing business. If efficiency can be greatly improved then certainly the business man as well as the urban citizen stands to gain materially. This may also herald a more pronounced effort to adapt business techniques to governmental problems and would also emphasize capital budgeting.

The third factor is the impact of federal legislation. Through the allocation of funds into urban projects federal agencies have emphasized coordination and effective performance at the local level. This trend has increased with each succeeding Congress within the last five years. Thus local officials and agencies are under pressure to increase the scope and effectiveness of their operations and this will lead many of them toward the adoption of fiscal planning and budgeting methods.

Also, the federal government has itself set a prime example. Capital budgeting is a form of public decision making, and attention has recently been focused on providing a more rational basis for making such decisions. Since it has had to grapple with problems of committing large amounts of public funds to long term projects with a high degree of uncertainty it is not surprising that these efforts originated with the Department of Defense. In 1961 the Department initiated an approach known as the Planning Programming and Budgeting System (PPBS). In 1965 all principal federal agencies were directed to apply this technique to their own operations and programs; several states and a number of cities have now instituted or are studying it. There is nothing dramatically new about PPBS. It combines marginal cost, cost benefit, and systems analyses in an attempt to deal with problems of resource allocation. It emphasizes the identifying of functional objectives; recognizes that present allocations have future implications; and requires the inclusion of all costs. Its key element is the identification and analysis of alternative methods of achieving the established objectives. The system does not pretend to make decisions but does give decision makers a clear idea of the options available to them.

Because of its inherent advantages, PPBS will gain considerable momentum in the future at the local level; and as with other innovations added impetus will also be generated by federal pressure.

### CONCLUSION

In a Supreme Court decision handed down last year it was noted that "institutions of local government have always been a major aspect of our system and their responsible and responsive operation is today of increasing importance to the quality of life of more and more of our citizens." This point is well recognized by local officials. The popular notion of local government as a sluggish bureaucracy is, like most such notions, founded on fancy rather than fact. Faced with a growing array of intractable problems, local government has, in spite of its inefficiencies, shown a remarkable ability to adapt and survive.

Although many substantial difficulties surround and pervade local government operations, the increasing range of techniques available and the growing interest in innovation indicate that the possibilities for achieving solutions to its problems are available. Among such techniques capital budgeting will undoubtedly be of major importance since it provides an essential link between fiscal and physical planning. It is likely to become a major addition to the operational approaches available to the administrator as he attempts to make local government even more responsible and responsive.



## Computer Programming In The High Schools

Wallace Hannum and Victor M. Yellen  
Department of Agricultural Economics and Rural Sociology  
Auburn University, Auburn, Alabama

The game of chess is fairly straight forward, with simple and well defined rules. It is easy to program a computer to recognize all valid and invalid moves and what makes up a win or a draw. Yet it is impossible to teach perfect chess.

We hear that the modern computer can do millions of operations a second; our first thought is to program the computer to analyze every possible move. By the words "analyze every possible move" we mean to try to move every possible piece, then observe every possible counter-move that its opponent might make, then look at every possible counter-move the computer may make, and so on. In this way the computer should be able to find a move which has a high probability of being a winning one.

At a rate of a few million calculations a second, this should be a short process. On second thought, we see that this is more complex. It has been estimated that a computer looking at one of the first moves in a game would have to examine  $10^{120}$  different possible combinations of the game. At the rate of two million calculations a second, this would take  $10^{113}$  seconds, or about  $10^{103}$  centuries. This means if we started the computer on making the first move of the game, we would never see it make the move. Not only could we not wait for the computer to finish the job, we can even prove the job cannot be done on the earth. We can easily show that  $10^{113}$  seconds is equal to about  $10^{109}$  hours. Even assuming that we could build a computer which took only 1 watt of electric power to operate, we would still need about  $10^{106}$  kilowatt-hours of electricity to power the computer for that time.

A well-known equation states matter can be transformed into energy:

$$E = MC^2$$

If we took the entire mass of the earth and converted all of it to energy, we would still only get about  $10^{35}$  kilowatt-hours of energy. In fact, there may not be enough energy in the entire universe.

All the foregoing illustrate the first assumption of programming: a computer cannot do everything. Can the computer play chess? The answer is yes, but not by using combinatorial theory but by using heuristic programming. Heuristic programming is that kind of programming which encourages the computer to learn. Computers can, although, perform tasks thought impossible less than ten years ago. Remember it is a tool just as a log table or a slide rule is a tool. What is the place of the computer tool in repetitious tasks? What should be offered at the high schools?

Two types of programs should be offered in the high schools: (1) a program for the future college student, and (2) a program for the students looking for a job after high school. The program designed for future college students should consist primarily of an introduction to computer programming and teaching the basic fundamentals of FORTRAN, the scientific programming language most widely used. This could be effectively taught in a two semester class meeting one hour daily. Thus a student could pursue

the regular college preparatory curriculum in high school and take the computer programming sequence his senior year. Knowledge of FORTRAN programming will greatly enhance a student's college education regardless of major field due to the wide spread computer applications. A benefit apart from formal course work would be the qualification for part time work as a computer programmer to help finance the cost of higher education and concurrently receive valuable work experience.

The only actual experience at Auburn has been with such a group. In a two year program, students from Auburn and Drake High Schools were taught the fundamentals of computer programming. The students were selected by their respective principals and received an eight-week course at Auburn. The criteria of selection were: (1) mathematical ability, and (2) desire to learn to use a new mathematical tool. The students were juniors and had taken or were presently taking algebra I and II and geometry. They received  $\frac{1}{2}$  unit credit for the course.

How was the short course received? The students were interested and diligent in their work. The course could have been improved by the addition of more problems. The only way an individual becomes a good programmer is by programming.

In 1966, the School Mathematics Study Group (MSG) developed six volumes that are to be used in a year course in algorithms, computation, and mathematics. This course is developed to serve the first group of students.

Besides this program for college bound high school students, a high school could also offer a more involved program for those students who do not plan to attend college but who will rather enter the work force upon graduation from high school. This program should be designed to occupy most of the last two years of the high school curriculum quite similar to a business education program. Computer programming would be included in this course of study but stress would be laid on data processing and applications in business and industry. Fields to be covered would include business organization, accounting, communication skills, programming, and systems development. Students completing this program should be able to go into business or industry with some marketable skills enabling them to perform a valuable service and obtain wages commensurate with their skill rather than be employed at a very uninteresting and unrewarding position as many high school graduates are today. IBM System Research Institute has developed a course manual for a data processing curriculum for those students vocationally oriented.

How does a school system justify the expenditure of \$1500 per month to teach such courses? The justification comes from only partial utilization of the systems for teaching. A system leased to keep attendance records, print report cards, print payroll checks can be time-shared to be used by students in computer oriented courses. This type of system will not only provide modern tools for the use of students but relieve the enormous administrative tasks now relegated to the classroom teacher.

In conclusion, such a program as outlined in this paper will benefit college bound students by acquainting them with computers which will be a part of their college education, and by giving them a skill which they could use in part time work while in college. Terminal high school students would be able to earn respectable wages in data processing in business and

industry, and would be working in a respectable position offering a challenging future. The schools involved would also benefit through computer application to many clerical and administrative tasks now performed by the teaching staff, thus freeing the classroom teachers to use their time for teaching and professional growth.

## Science—A Process Approach Or “The Chart Before The Course”

Joseph C. Thomas  
Department of Science  
Florence State University  
Florence, Alabama

### SCIENTIFIC AGE

It is generally agreed that the current day will go down in history as being the scientific age or at least the start of such an age. We are aware of the great importance of science but to indicate the actual importance of the age in which we live, the following illustrations may be used.

(1) The textbooks that we use or that we have studied from in the area of science talk about the great scientists of the past such as Galileo, Pasteur, Newton, and others. Yet we find that of all the scientists that have lived on this earth, approximately 95 percent of them are still living today.

(2) Let's assume that you are a “science expert” and by that it is meant that you know everything there is to be known about science. Obviously, there is no such person. Let's assume, however, that you are this hypothetical person and that you decide to keep up in the area of science. To do this, you will read about new discoveries in science as they are printed in the various scientific magazines. You read at 200 words per minute and you do not stop to rest your eyes, to eat, to sleep, or to look up the material. Someone furnishes the magazine articles to you and all you do is read. Yet every minute that you read you are getting further behind in the knowledge of science.

(3) It has been estimated on a very conservative basis that we have learned more about science and this physical world in which we live in the last 50 years than was learned in the previous 500 years. Or, even more conservatively it has been stated that since the year 1900, we have learned more about science and the physical world in which we live than we did in all the previous years of history put together.

(4) We live in an atomic age in which the power is tremendous. A few years ago the Russians were testing hydrogen bombs and in the process of their tests, a 30 megaton hydrogen bomb was set off. It is hard to visualize 30 million tons of TNT equivalence. One person has indicated that if 30 million megatons in equivalent TNT were loaded into box-cars and formed into a railroad train, that one single continuous train of boxcars would stretch from Melbourne, Australia, to New York City. Or, if you look at the equivalency here in relation to all of the explosives that were set off during the complete World War II, you would find that here we are talking about 30 megatons of TNT as opposed to only 2½ megatons for the entire war.

From this it is obvious that we are living in the age in which science is king and is giving the direction to our society.

### GENERAL PUBLIC AWAKENING

Even though we have agreed that we are living in the scientific age, the general public of the United States appeared to be totally unaware of

the importance of science. As long as they were furnished satisfactory improvements in the areas of home living, transportation, and other everyday activities, they were content in letting the scientists be the scientists. However, the sleeping public was rudely awakened when in October of 1957 the Russians put Sputnik I into space. Immediately the furor was heard from coast to coast and the main question was two-fold: (1) Why didn't we put up the first satellite?, and (2) What is wrong with our program in science that we are so far behind the Russians? As a result of the furor by the general public at that time, several new programs under the National Science Foundation were established.

### DILEMMA OF TEXTBOOK WRITERS AND TEACHERS

Due to the explosion which increased scientific knowledge tremendously, the textbook writer was in a great dilemma. His problem was how do you keep up with all the new developments. If they were included in the new editions of the textbooks, then the textbooks either got thicker and thicker or the print became smaller and smaller. The other alternative for the textbook writer was to leave out an amount of old material to equal the new material, but then came the great dilemma of deciding which principles of old could be left out to provide space for the new. The high school and elementary school teachers were trapped even more in this dilemma. As more and more material was included in the textbooks, it became even harder "to cover" the textbook.

It is apparent that a stalemate was reached and since it was extremely hard to decide, either by the textbook writers or the teachers, just what could be left out, it was decided that a fresh start should be made and that courses be completely re-organized and developed around a central theme.

### DEVELOPMENT OF NEW COURSES

When the plan of re-organization or development of new courses was first conceived, the ideal situation was visualized in which the science program would be organized giving unity and flow of subject matter from kindergarten through the twelfth grade. Such a unified course was given the name of the K-12 plan. Great promise was given for the K-12 plan in which principles would be taught with little repetition as the student progressed through the various grades. In order to bring about this tremendous revision, considerable help, backing, and support were needed. A few private organizations did lend support but it was the National Science Foundation that rescued the plans of these educators with a vision.

With the financial support of the National Science Foundation, numerous new programs in science were started. Some of the earlier programs were:

- (1) BSCS Biology
- (2) PSSC Physics
- (3) CBA Chemistry
- (4) CHEM Study Chemistry

These programs were all organized around a central theme and each departed mildly to drastically from the then current textbooks in the respective subjects. However, you will note that all of these programs were for the senior high school level and thus it appears that we started at the top



and began working backwards rather than at the bottom and building up a program as was envisioned by the K-12 plan.

After the high school developmental science programs were already under way, the elementary school science programs were started. These programs were actually started in self-defense because of the problems that were created by beginning with the upper level courses first in the developmental pattern. As these upper level courses were developed, more and more subject matter was "pushed down" into the elementary grades. It is now possible to see coursework being offered in the elementary school that at one time was considered senior level high school or even freshman level college work. In addition to that, it was soon found that the new high school experimental programs demanded a better and different type preparation from the elementary school and the junior high school in order for the students to succeed in the new experimental programs. From these demands by the upper level courses, numerous programs in elementary school science have been started and most have been financed by the National Science Foundation. The following are illustrations of this:

- (1) Science—A Process Approach
- (2) SCIS
- (3) ESS.

The support for all of these courses has been tremendous for in the last ten years the National Science Foundation has contributed one hundred million dollars to the development of these courses. In addition, the U.S. Office of Education has provided several additional million dollars for development purposes and of course, there are numerous private organizations who have contributed liberally to various experimental programs in this area.

### SCIENCE—A PROCESS APPROACH

The program that is of particular interest for this paper is the elementary school science program entitled, Science—A Process Approach. This program, for children in kindergarten and grades one through six, was developed by the Commission on Science Education of the American Association for the Advancement of Science during the period 1962 to 1967. The five year effort was financially supported by the National Science Foundation and involved the enthusiastic participation of more than 100 scientists and educators, representing a wide spectrum of backgrounds, interests, and specialized knowledge. Upon completion of the developmental procedures, the American Association for the Advancement of Science turned over the completed work to the Xerox Corporation for publication of the materials for use in the elementary schools.

The educational philosophy and psychology that underlie this particular program have been defined by Dr. Robert M. Gagné, Professor of Education, University of California, Berkeley, California. Dr. Gagné has given guidance to the program from its conception and has been a leading influence in the development of the process approach. Today there is considerable discussion concerning process versus content but the question for the elementary school concerns the actual importance of rote memorization of facts. Is it more important to memorize isolated facts or is it more important to discover some processes that are used in the scientific endeavors

in various laboratories? The main question that is posed is as follows: "What does the scientist do when he is in the laboratory during which time scientific endeavor is conducted?" The answer given by Dr. Gagné and the Commission on Science Education of the American Association for the Advancement of Science is that the scientist probably does the following things instead of rote memorization of facts.

- (1) Observes
- (2) Measures
- (3) Infers
- (4) Uses numbers
- (5) Communicates
- (6) Forms hypotheses
- (7) Experiments
- (8) Many other processes

The reasoning then follows that if the scientist is doing these things in the laboratory, shouldn't the elementary school child start developing the processes indicated. This means then that the program is developed around specific processes to be learned and that the science content is incorporated only as it helps to develop a specific process. You see from this that the whole orientation of the program is completely reversed to the traditional program in which a teacher attempts to gain process through teaching content.

Once the process approach was established, the next great task was to decide what processes should be studied, on what grade levels they should be studied, and in what order they should be studied. After considerable debate, it was decided that the following eight simple process skills should be taught in the primary grades.

- (1) Observing
- (2) Using space/time relationships
- (3) Using numbers
- (4) Measuring
- (5) Classifying
- (6) Communicating
- (7) Predicting
- (8) Inferring

The more integrated process skills were retained for study in the intermediate grades. These integrated processes were defined as follows.

- (1) Formulating hypotheses
- (2) Controlling variables
- (3) Interpreting data
- (4) Defining operationally
- (5) Formulating models
- (6) Experimenting

The basis for the complete program objectives is the observable performances of the process skills by the individual student. For this reason, there are no textbooks for the children. The teacher has a complete set of materials with which he or she is able to direct all the activities of the student as he performs various process skills. Since there are no textbooks, the course becomes very much an activity-centered program. It might be added at this point that since no textbook materials are produced for each child, this program could be used in connection with a standard textbook



series so that a teacher could teach both content and process during the year.

Each lesson to be presented on a behavioral objective is complete and consists of the following:

- (1) Listing of process and level within the process that will be studied
- (2) Name of the exercise
- (3) Objectives of the lesson
- (4) Sequence in the total program
- (5) Rationale
- (6) Vocabulary
- (7) Materials needed
- (8) Instructional Procedure
  - (a) Introduction
  - (b) Activity 1
  - (c) Activity 2
  - (d) Generalizing Experience
- (9) Appraisal
- (10) Competency Measure

All of these parts are bound together in a lesson booklet and everything needed to carry out the lesson is contained in the individual lesson booklet.

The equipment needed for the complete program in Science—A Process Approach may be, for the most part, home-made, or if the teacher wishes, ordered in kits for each of the various levels of work. In every case, the equipment is as simply made as is practically possible.

Once the lessons are defined and the processes to be studied are identified, there is a giant problem of organization of the coursework or lessons into a unified program. Each of the processes selected will cover several lessons in which the difficulty level increases. Obviously, the difficulty level increases with progression through the grades. Also, one process is not studied exclusively but rather may be considered among several processes during the period of a month's time. Since each lesson builds on the previous one and since several of the processes tend to work together, there was a great need for some type of chart of hierarchy dependencies to be established. As it worked out in this particular course, the hierarchy chart was developed first and then lessons were developed making use of science content that would illustrate the particular process in question and on the particular level needed. Thus, the hierarchy chart was developed before the course content, hence the pun on the old phrase of having "the cart before the horse" is developed as having "the chart before the course". However, once the hierarchy chart was fully developed and the lessons organized in order to teach the processes indicated, it became possible for a teacher to locate a student on the hierarchy chart and therefore be able to distinguish which lessons he should take up next. This positioning of a particular student is done using comprehensive, competence measures which are also provided with the course.

Whenever possible, the teacher should work individually with the student or at least with very small groups since the objectives of each of the exercises are behavioral and must be observed.

The materials for the various grades are organized in boxes that are labeled A through G corresponding to kindergarten through the sixth grade. Each box contains sufficient number of units for one year's work. However,

since each student should progress at his own rate, it would be anticipated that the students in any one classroom might be working in a variety of the boxes labeled A through G. For this reason, they are given letter names instead of grade numbers.

### SUMMARY

In summary, it appears that we are living in a scientific age and will continue to depend upon science for some time. The development of science depends primarily upon the number and quality of scientists that we are able to produce in the future. Since, generally speaking, the scientific attributes of the child are developed in the elementary or secondary school, it becomes quite important that the science program in elementary, junior high, and senior high schools be the best possible. The National Science Foundation has taken a giant step in helping to provide numerous new courses to meet this increasing demand for qualified people in the area of science.

Of the programs that have been developed recently, the program sponsored by the American Association for the Advancement of Science appears to be rather unique in that process rather than content is stressed. The noteworthy and distinctive features of Science—A Process Approach were summarized in a pamphlet by the Commission on Science Education of the American Association for the Advancement of Science as follows:

(1) Instructional materials are contained in booklets written for, and used by, the teacher. Accompanying kits of materials are designed for use by teacher and children. Except for certain work sheets in the later grades, there are no printed materials addressed to the pupil. What the teacher does is to organize and set up science problem situations designed for participation by the children.

(2) The topics covered in the exercises sample widely from the various fields of science. The exercises are ordered in sequences of instruction to provide a developmental progression of increasing competence in the processes of science.

(3) Each exercise is designed to achieve some clearly stated objectives. These are phrased in terms of the kinds of pupil behavior which can be observed as outcomes of learning upon completion of the exercise.

(4) The coverage of fields of science is broad. Mathematics topics are included, to be used when needed as preparation for other science activities. Some of the exercises draw from the social and behavioral sciences. Most involve principles in physics, biology, and chemistry, with a lesser representation of earth sciences and astronomy.

(5) What is to be learned by the children is an accumulative and continually increasing degree of understanding of, and capability in, the processes of science. Progress begins in the kindergarten with observation and description of object properties and motion, and advances through the sixth grade to the design and conduct of scientific experiments on a variety of topics.

(6) Methods for evaluating pupils' achievement and progress are an integral part of the instructional program. Each exercise contains a test of pupil achievement reflecting the objectives of the exercise and providing means of assessing its outcome. In addition, separate measures have been

developed for use in determining pupil attainments in process skills prior to instruction.

(7) A comprehensive text for the education of teachers is also an integral part of the program. This includes essential general information on the science principles and processes involved in the program, and a set of exercises providing opportunities for teachers to practice relevant instructional techniques.

## A Regression Analysis Of The Rate Of Off-Farm Migration Of Farm People In The Tennessee Valley Region

Venkareddy Chenmareddy  
Saginaw Valley College  
University Center, Michigan

A number of studies (1, 2, 3, 4, 5, 6, 7 8) have indicated that off-farm migration of farm people is associated with age, educational level, nonfarm experience of farm people, expected returns in the nonfarm sector, and the costs of migration. In particular, on the basis of data on state economic areas in the Southeast, Diehl (3) concluded that off-farm migration is negatively associated with farm income and capital gains in agriculture and is positively correlated with nonfarm experience, percentages of farm people in age group 14-24 and percentages of Negroes. The objective of this article was to test the same relationships for the Tennessee Valley region, a part of the Southeast section of the United States. Data are, therefore, based on nineteen state economic areas in the Tennessee Valley region. Hence, the results obtained in this study are comparable with those obtained in Diehl's (3) study for the Southeast.

### THE MODEL AND DATA

Two regression models for the rate of off-farm migration of farm people are hypothesized as follows:

$$(1) Y = a_0 + a_1 IF + a_2 G + a_3 S + a_4 A + a_5 R + e_1$$

$$(2) \log Y = b_0 + b_1 \log IF + b_2 \log G + b_3 \log S + b_4 \log A + b_5 \log R + e_2$$

Where  $a_0, a_1, a_2, a_3, a_4, a_5$ , are the constants in the first regression model and  $b_0, b_1, b_2, b_3, b_4, b_5$ , are the constants in the second regression equation.  $e_1$  and  $e_2$  are the random errors in the first and second regression equations respectively.

$Y$  = Net off-farm migration rate of farm people.

This was computed by taking the difference between the 1960 farm population and the expected end-of-decade farm population on the basis of the 1950 census and dividing the difference by the expected end-of-decade farm population. The expected end-of-decade farm population was obtained by adding the difference between the reported number of births and deaths during the decade to the farm population in 1950 adjusted to the 1960 definition. This was used as the denominator because it represents those people who are exposed to the possibility of migrating.

$IF$ : Net farm income per capita in 1949

In the absence of net farm income data on the basis of state economic areas an approximate measure was used. This was obtained by subtracting specified farm expenditures from total value of farm products sold. This was assumed to be the expected farm income foregone by the potential off-farm migrant during the period 1950-1960.

*G: Capital gains foregone*

It is computed as the difference between the value of land buildings per acre in 1960 and 1950. The farm people who migrated might have foregone these capital gains and hence it is a cost of migration.

*S: Skill variable*

This variable is assumed to reflect the nonfarm experience of farm people. This was computed as the percentage of rural farm males 14 years old and older in 1950 enumerated in four occupational groups: craftsmen and foremen, operatives, laborers (except farm and mine), and farm laborers and foremen.

*A: Percentage of farm people (both males and females) who were 10-25 years old in 1950 to the total farm population in 1950.*

This variable was chosen because younger farm people are more likely to move to nonfarm sectors because they are not usually committed to farming.

*R: Race variable*

This variable is a percentage of Negro farm population to total farm population in 1950. This variable is quite important in explaining the variation in off-farm migration rate because any differences in discrimination between two sectors may lead to off-farm migration. The lower the discrimination of Negroes in the nonfarm sector as compared with that in an economic area, the higher will be the off-farm migration rate.

## EMPIRICAL RESULTS

The means and standard deviations of all the chosen variables for the Tennessee Valley and the Southeast are given in Table 1.

TABLE 1. Means and standard deviations of farm income (IF), capital gain (G), skill (S), percent of population 10-24 years old (A), percent of Negroes (R), and the rate of off-farm migration (Y) in the Tennessee Valley and Southeast.

	Tennessee Valley		Southeast <sup>a</sup>	
	Mean	Standard Deviation	Mean	Standard Deviation
IF	161.63	80.00	213.59	142.73
G	44.99	13.05	57.36	30.53
S	7.11	2.12	8.34	3.27
A	27.69	2.12	28.32	2.14
R	7.94	9.52	24.99	23.36
Y	51.53	11.41	52.50	12.80

<sup>a</sup> Source: Diehl, William D. 1966. Farm-Nonfarm Migration in the Southeast: A Costs-Returns Analysis. J. of Farm Economics, February: 5.

The off-farm migration rate in the Tennessee Valley is almost equal to that in the Southeast. However, all the independent variables in the Valley are lower than those in the Southeast. The simple correlations among all the variables for the Tennessee Valley region are presented in Table 2.

It is quite encouraging to find that none of the correlations between any two independent variables is above 0.65, indicating that the problem of

TABLE 2. Simple correlations between farm income (IF), capital gains (G), skill (S), percent of population 10-24 years old (A), race (R) and the rate of migration (Y).

Variables	I	G	S	A	R	Y
IF	1.0000	0.1025	-0.6441	-0.5794	0.1812	-0.7538
G		1.0000	-0.2927	-0.0131	-0.1167	-0.2001
S			1.0000	0.3869	-0.2382	0.5384
A				1.0000	0.1397	0.5927
R					1.0000	0.2534
Y						1.0000

multicollinearity is not faced in the regression analysis. The signs of correlations between the dependent variable and each independent variable are found to be as expected. The regression coefficients of the independent variables, their standard errors both in the linear and logarithmic regression equations are presented in Table 3.

TABLE 3. Regression coefficients, their standard errors in the linear and logarithmic function.

Variable	Linear function	Logarithmic function
Constant	46.0839 (30.1222)	2.1368 (0.8038)
IF	-0.0955 (0.0298)	-0.4140 (0.0934)
G	0.0345 (0.0105)	-0.0166 (0.0104)
S	0.7836 (0.3920)	-0.0078 (0.1253)
A	0.4738 (0.1650)	0.3094 (0.1450)
R	0.4725 (0.1855)	0.0813 (0.0265)
R <sup>2</sup>	0.7491	0.7816
S <sub>e</sub>	6.9081	0.0547
d.f	13	13

In the case of linear regression, the regression coefficient of farm income, capital gains, age, and race variable is significantly different from zero at the 5 percent level. The regression coefficient of the skill variable is different from zero at the 10 percent level. In the case of logarithmic regression, the regression coefficient of capital gains and the skill variable is not different from zero even at the 10 percent significance level. The coefficient of a multiple determination is 0.75 in linear regression, whereas it is 0.78 in the logarithmic regression. This indicates that at least 25 percent of the variation in the off-farm migration rate is explained by the chosen independent variables in both the regression equations. For interpretation purposes, the linear regression is discussed below.

The regression coefficient of farm income is -0.0955. This indicates that if farm income per capita increases in an economic area by \$10 over the regional average of \$161.63, the off-farm migration rate is expected to be less by 1 out of 100 of the expected end-of-decade farm population (from the regional average of \$51.53). Similarly, decreases in farm income per capita may induce farm people to move out of farming. This implies



that farm prices and production policies and direct and indirect subsidies for farmers may have a retarding effect on off-farm migration of farm people even in the periods of generally increasing nonfarm employment.

The regression coefficient of capital gains in agriculture indicates that in an economic area, higher expected capital gains may lead to lower off-farm migration rate. If the capital gains per acre in an economic area increase by \$100 from the regional mean the off-farm migration rate may be lessened by about  $3\frac{1}{2}$  persons per 100 of end-of-decade farm population.

The regression coefficient of the skill variable is 0.7836 which shows that if the percentage of rural farm males in the farm population who are having nonfarm experience is 10 percent greater in an economic area than the regional average, about 8 more persons out of 100 end-of-decade farm population are expected to move out to nonfarm sector, other things remaining equal.

The regression coefficient of age variable is 0.4738. This means that if an economic area has 10 percent more people 10-24 years old than the regional average, the off-farm migration rate will be higher by 4.5 than the regional average.

The regression coefficient of race variable is 0.4725 which indicates that if the percentage of Negroes in the farm population is 10 percent larger in an economic area than the regional average, the off-farm migration rate is expected to be higher by 4.7 than the regional average.

#### ELASTICITIES OF OFF-FARM MIGRATION RATE OF FARM PEOPLE

The regression coefficients in the logarithmic equation are actually the elasticities of migration with respect to each independent variable. The elasticities in the linear regression at the regional mean levels are estimated by multiplying the regression coefficient by the corresponding ratio of the average independent variable to the average migration rate. Table 4 gives the elasticities of migration at the mean levels of the independent variables in both the linear and logarithmic regressions.

TABLE 4. Elasticities of migration

Variable	Linear Regression	Logarithmic Regression
IF	-0.2995	-0.4140
G	-0.0312	-0.0166
S	0.1081	-0.0078
A	0.2546	0.3094
R	0.0728	0.0813

The elasticities of off-farm migration rate of farm people with respect to farm income, age variable, and race variable are lower in the linear regression than in the logarithmic regression. Those with respect to capital gains and skill variables are higher in the linear regression. The elasticity of migration with respect to skill variables is quite low in the logarithmic regression as compared with that in the linear regression. This might be due to the fact that the coefficient in the logarithmic regression is not significantly different from zero even at the 10 percent level.



## SUMMARY AND CONCLUSIONS

The objective of this article was to test the relationships between off-farm migration rate and each of the variables: farm income per person, capital gains per acre, nonfarm experience, percentage of young rural farm people, and the race variable. For this purpose, a multiple regression analysis was made using data on state economic areas in the Tennessee Valley region. The signs of the regression coefficients of the independent variables for the Tennessee Valley region are the same as those obtained by Diehl (3) for the Southeast. However, as expected, the magnitudes of the coefficients are different. Off-farm migration rate in the Tennessee Valley is found to be negatively associated with farm income per capita, capital gains per acre, and positively correlated with the off-farm experience of rural farm males, percentage of farm people 10-24 years old, and the percentage of Negroes. This leads to the conclusion that farm prices and production policies, helping to generate higher farm income and expected capital gains per acre, may retard off-farm migration of farm people. Government actions, such as vocational training may enable farm people to improve their non-farm skills and thereby help accelerate the rate of off-farm migration. Enactments, in the area of Civil Rights which inhibit discrimination of Negroes in the urban areas may also help increase the rate of off-farm migration of farm people.

## LITERATURE CITED

1. Baumgartner, H. W. 1965. Potential mobility in agriculture: some reasons for the existence of a labor-transfer problem. *J. Farm Economics* 47: February.
2. Bowles, Gladys K. 1957. Migration patterns of the rural farm population, thirteen economic regions of the United States, 1940-1950. *Rural Sociology* 22: March.
3. Diehl, William D. 1966. Farm-nonfarm migration in the Southeast: A cost-returns analysis. *J. Farm Economics* 48: 1-11.
4. Gisser, Micha. 1965. Schooling and the farm problem. *Econometrics* 33: 582-592.
5. Heady, E. O., Back, W. B. and G. A. Peterson. 1953. Inter dependence between the farm business and the farm household with implications on economic efficiency. Res. Bul. 398, Iowa Ag. Expt. Station.
6. Johnson, D. Gale. 1963. Efficiency and welfare implications of U.S. agricultural policy. *J. Farm Economics* 45: 338-339.
7. Roy, Pradipto. 1961. Factors related to leaving farming. *J. Farm Economics* 43: August.
8. Sjaastad, Larry A. 1962. The costs and returns of human migration. *J. Political Economy* 70: 80-93, October (supplement).

## A New Approach To College Teaching; Or Is It?

Army Daniel, Jr.  
Alabama A and M  
Normal, Alabama

Books have been written and educators have theorized on the best methods of instructing college students. Many have argued that it is difficult enough to teach one of the sciences to a group of freshmen. It is even worse, they say, to combine two of them. It is almost unspeakable to dream of a natural science course where physics, chemistry and biology are taught as a single, one year course!

Meanwhile ISE (Institute For Services To Education) was wrestling with this educational "bear." The curriculum section was busy working on units in English and Mathematics. Like the forerunners of CRP (Curriculum Revision Program), the problem of developing the idea ahead of the necessary materials (books and ready references) was apparent. Having been funded through the U.S. Office of Education, The Carnegie Foundation, and supplementary funds from OEO and OGO (Office of Economic Opportunity) and the Ford Foundation, the alarm was sounded.

Thirteen colleges were invited to write proposals (with proper guidelines) with the hope that some six or seven would respond. Much to the surprise of everyone, all 13 responded. Thus, the project acquired a name—The Thirteen Colleges Curriculum Revision Program.

### *Subject Matter Areas*

The program embraced English, mathematics, natural science and social studies. None of these areas was approached from a conventional method then in existence. A "new" technique was being tossed around; this would necessitate a curriculum writing conference. Surely, no one expected 100 teachers, 13 directors and 13 counselors to write a completely new curriculum (void of all presently existing materials) in the eight weeks allotted in the summer of 1967.

The conference was held at Pine Manor Junior College, located in the suburbs of Boston, Massachusetts (Chestnut Hills). The atmosphere was certainly conducive to academic stimulation. Experts were brought in from all over the country and abroad, but the major task rested with the teachers, both the seasoned and the not so seasoned, who were to confront the 1,250 youngsters in September, 1967.

### *The Organization*

To teach or not to teach, certainly seemed to be the appropriate question. What will the 100 teachers teach these youngsters? Why should millions of dollars be spent in a program that some had apprehensions about from the very start? Dr. Sam Proctor, President of ISE (and past President of A. & T. College in North Carolina), Dr. Jerrold R. Zacharias, Professor of Physics, M.I.T., Dr. Herman Branson, Professor and Head of the Department of Physics, Howard University, Dr. Phillip Morrison, Professor of Physics, M.I.T. and Dr. Conrad Snowden, Associate Director of ISE were convinced that this *package* could revolutionize the whole approach to col-

lege teaching. So the committee met with the Presidents of the 13 colleges involved. Some gave this "baby" their blessings, others said wait and see.

Equipped with the recommendations of its own curriculum division, and spiced by the inspiration of the men mentioned above, ISE marched forward. There were plenary sessions held (those where everyone came together for direction), but for the most part, the "workshops" were within the subject matter disciplines.

### *The Goals*

- 1) To create the kind of academic atmosphere in which students and teachers are willing and free to learn.
- 2) To seek truth; not so much *who* is right, but rather, *what* is right.
- 3) To stimulate inquiry and encourage problem solving.
- 4) To help each student discover that he is a person with dignity and worth.
- 5) To develop a systematic approach to problem solving that is applicable to every area of human endeavor.

### *Participating Institutions*

Alabama A. & M. College	Lincoln University
Normal (Huntsville), Alabama	Lincoln, Pennsylvania
Bennett College	Norfolk State College
Greensboro, North Carolina	Norfolk, Virginia
Bishop College	North Carolina A. & T. University
Dallas, Texas	Greensboro, North Carolina
Clark College	Southern University
Atlanta, Georgia	Baton Rouge, Louisiana
Florida A. & M. University	Talladega College
Tallahassee, Florida	Talladega, Alabama
Jackson State College	Tennessee A. & I. University
Jackson, Mississippi	Nashville, Tennessee
	Voorhees College
	Denmark, South Carolina

### *Breakdown of Support*

Conference Support .....	The Ford Foundation
Curriculum Program Support .....	U.S. Office of Education
	Office of Economic Opportunity
	National Science Foundation
Administrative Support .....	Carnegie Foundation

### *Description of Instruction*

Perhaps the most marked departure from conventional methods in the CRP is active student involvement, involvement in the whole thought process. Equally as significant is the boldness with which the teacher admits that the student might discover a better way to get the job done. Or he might find, by exploring together, that there is nothing sacred about course outlines or goals that are teacher-made. Not all 100 teachers were in accord with this idea of student-centered, rather than teacher-centered, learning. Many "old timers" felt that to allow students to do anything that was interesting to them would create pure chaos.

But those who were dedicated to establishing this method of teaching as a more effective learning tool for today's young college students had passed the point of no return. It was quite clear that present methods were not meeting the needs of this very large, and often forgotten segment of our population.

### *Description of Students*

The students in the curriculum program were truly a cross section of the freshman class. Approximately 90 percent of the students were from homes where the family income was below the national norm. Many of these students were eating three meals a day for the first time in their lives. Others came from big city slums where school, and life in general, seems to stand still for them. About 10 percent came from middle class families where the conditions were slightly altered, but not much. Thus, we had a cross section of rural and urban, poor and not so poor, intelligent and not so intelligent, happy and not so happy college students. Some had ceased to hope and dream; others had watched their dreams turn to nightmares, and then the nightmares became living reality.

Geographically, they represented the East, Midwest, Southeast, and South. A handful were from northern cities. While race was not a factor in student selection, the bulk of our groups were Negroes, for they represented predominately Negro colleges. The one thing they all had in common was that they were all members of that year's freshman class.

Many of these students lacked the rich background in the Arts and Sciences, that so many Americans are heir to. They were correspondingly limited in vocabulary and speech. Many had lost interest in self expression and still others never had it. In the past many of these students had been the college drop-outs after a semester, two quarters, or certainly no more than a year.

In previous years these had been the students for whom lecturing in the course's language might have proven quite fruitless. Some sat and wrote notes and prayed for the bell to ring. Once outside they tried hard to forget the bitter experience just concluded. This was a fairly accurate description of the Alabama A. & M. group in September, 1967; and I would venture to say that this was true at most of the 13 colleges.

### *The Science Area*

In the natural sciences we chose five units; each to be treated from an integrated point of view (that is chemistry, physics, and biology).

- 1) Measurement
- 2) Force and Motion
- 3) The Nature of Science
- 4) Energy
- 5) Genetics and Reproduction

### *Enrichment Units*

- 1) Waves
- 2) Atomics
- 3) Astronomy—Stellar

### *Observations*

After seven months in the CRP, student centered curriculum, we could proclaim 90 percent response in most classes. It would be foolish to suggest

that this is a success story, but it was a beginning. The biggest question facing colleges today is, "How to recruit teachers who can turn on, in a positive way, all this intellectual potential?" How indeed, to stimulate them to believe in themselves, in humanity, and more importantly, in the American way of life—something many of them have had only in small dosages.

It is much too early to give an answer to the question of how our curriculum students will stack up, but test results (Tables 1, 2) indicate they are doing slightly better than the control group.

### *Summary and Conclusions*

We feel that this method of student inquiry, student oriented instruction will catch on. The implications as well as the applications are so expansive that we seek a revolution in college teaching not because we say so, but because the method warrants it.

Certainly the road won't be easy, for there are still many college presidents, deans, department chairmen, and fellow teachers who aren't convinced that what we have is a better way to impart knowledge—a more lasting method. For what we are told we soon forget. Much of what we read is lost in the garbage of modifying phrases. But what we work through becomes a part of us. This is why I can say with conviction that I know this is a better way. For those who doubt it, I ask, have our present methods solved the problem?

### *Acknowledgements*

Curriculum Revision Staff of ISE; my colleagues at Redstone Arsenal, Solid State Physics Branch, Physical Sciences Laboratory, Huntsville; my colleagues at Alabama A & M College; and my students, the human guinea pigs in this experiment

TABLE 1. A comparison of average scores per 100 students.

NAME OF TEST	CURRICULUM GROUP	CONTROL GROUP
PTI Aptitude	28.17	23.17
SRA Verbal Aptitude	32.00	24.33
SRA Non-verbal	44.17	36.83
Verbal Power		
Test of Concept Equivalents	39.50	40.50
Wide Range Vocabulary	45.33	46.50
Scale		
I PAT Anxiety	31.67	26.00
ACT College Test (American)	13.00	12.00

TABLE 2. Average scores on a standardized test by grade level

PERIOD CONSIDERED	CURRICULUM GROUP	CONTROL GROUP
September, 1967	10th Grade	10th Grade
March, 1968		
After Seven Months	12.0 Grade	11.3 Grade
Standardized Test		
March, 1968	60th %	48th %
Standardized Test		
September, 1967	39th %	40th %



# Durability Of Glued Finger Joints In Southern Pine<sup>1</sup>

D. B. Richards  
Forestry Department  
University of Kentucky  
Lexington, Kentucky

## INTRODUCTION

While there have been numerous studies on the exterior durability of glue joints in plywood and laminated wood, there is very little information on the durability of glued end joints in wood. The structural laminating industry is rapidly converting from simple scarf joints to high strength finger joints for end jointing lumber. For those structural laminates that receive outdoor exposure, it is extremely important that the end joints withstand this exposure. The tests here reported, although limited in number, yield some valuable information on end joint durability.

## MATERIALS AND METHODS

Four glues were used: a room temperature setting phenol-resorcinol formaldehyde (designated PR), a melamine formaldehyde (designated M), a blend of 5 parts melamine formaldehyde to 3 parts urea formaldehyde (designated 5M:3UF), and a urea formaldehyde strongly fortified with crystalline resorcinol plus paraformaldehyde so that the dry solids ratio was 20 parts crystalline resorcinol to 45 parts urea formaldehyde (designated 20R:45UF). One joint, the Auburn E-joint, was used for both end-joints and corner joints. This joint is 0.984 in. long, has 0.016 in. tips and a slope of scarf of 1:8 on the fingers. All specimens were cut from 5/4 by 5 in. kiln dried southern pine (*Pinus taeda*). Two triangular frames were formed with a 60° finger jointed corner joint at each corner. These corner joints were cold pressed with a phenol-resorcinol glue. Longitudinal members to be fastened to the triangular frames were formed by end-jointing short members using the four glues mentioned earlier. Each end joint was hot pressed for 10 min at 300 F and 150 psi. All specimens were dressed to 1.062 in. in thickness and approximately 4.75 in. in width after end or corner jointing. They were then cold soaked in 5 percent pentachlorophenol in #2 fuel oil to prevent decay and installed on a flat roof at Auburn, Alabama, (32°37'N., 85½°W.) where they were exposed, unprotected, to outdoor weathering for approximately 9 years. The joints were inspected in detail at 6½ years and again at termination of the test. In the terminal inspection the joints were also subjected to a "knife picking" technique that consisted of forcing a knife into any point of delamination on the face of the joint and prying until the joint or the wood split back. Picking was continued until no more joint could be exposed. This technique exposed not only delaminated areas, but any areas in which the glue joint was weaker than the splitting resistance of the wood. Thus exposed, the area of glue failure in the outer scarfed region on both faces of each joint could be estimated as a percent of the area of this outer scarfed region.

<sup>1</sup> Fabrication and erection of these test frames were carried out while on the staff of the Forestry Dept., Auburn University. Appreciation is expressed to W. B. DeVall and E. J. Biblis of the Forestry Dept., Auburn Univ., for their cooperation in facilitating the 9 year inspection.

TABLE 1. Condition of glued finger joints (Auburn E-joint)<sup>1</sup> after outdoor exposure at 32°37'N., 85½°W.

Joint Number	Glue <sup>2</sup>	Joint type	After 6½ years exposure		After 9 years exposure	
			Edge Delamination	Face Delamination	Edge Delamination	Glue failure in outer slopes after knife picking
			%		%	%
1	PR	60	40	Slight	90	35
2	PR	60	80	Moderate	90	45
3	PR	60	60	Heavy	95	60
4	PR	60	40	Slight	85	35
5	PR	60	30	Very Slight	90	20
6	PR	60	35	Moderate	80	50
Average of 6 corner joints					88	41
7	PR	End	10	Slight	55	20
8	5M:3UF	End	0	Failed	55	Failed
9	20R:45UF	End		0		2
10	20R:45UF	End	50	Very Slight	95	30
11	PR	End	25	Slight	80	35
12A	M	End	70	Moderate	Failed	Failed
12B	M	End	90	Failed		Failed
12C	M	End		100%		Failed
13	5M:3UF	End	65	Heavy		Failed
14	5M:3UF	End	Failed	Failed	Failed	Failed
15	5M:3UF	End		Failed		Failed
Average of 4 durable end joints					71	22

<sup>1</sup> Auburn E-joint is a finger joint with 0.984 inch fingers, 0.016 inch tips, and a slope of scarf of 1:8 on the fingers.

<sup>2</sup> PR = phenol-resorcinol; M = melamine formaldehyde; UF = Urea formaldehyde; R = crystalline resorcinol (added as fortifier).

## RESULTS AND DISCUSSION

Neither the melamine urea (5M:3UF) nor the pure melamine formaldehyde glue (M) showed long term exterior durability in finger joints. Four of these joints had failed by 6½ years and the remaining 3 had failed by the ninth year (Table 1). Examination of these failed joints substantiates their inadequacy by revealing practically no wood failure at any place throughout the thickness of the joint. It is impossible to excuse their poor performance by postulating an inadequate cure at the center or a damaging overcure at the surface since in either event there would be some level in the thickness with proper cure which would lead to wood failure rather than glue failure at that level.

The 2 phenol-resorcinol (PR) joints and the 2 resorcinol-urea (20R:45UF) joints were the only end joints to survive the 9 year exposure without delaminating completely. The phenol-resorcinol is well known for its durability. The stellar performance of the resorcinol-urea is gratifying. It substantiates the work of Blomquist and Olson<sup>2</sup>, who demonstrated the durability of such formulations, and supports some accelerated testing studies of the author. The results of visual inspections at 6½ and at 9 years give the impres-

<sup>2</sup> Blomquist, R. F. and W. Z. Olson. 1955. Durability of fortified urea-resin glues in plywood joints. For Prod. J. 50:56.



sion that the 20R:45UF joints were noticeably superior to the PR joints (Figures 1 and 2). In view of the limited number of specimens the above evidence should not be taken to indicate 20R:45UF is more durable than PR. It can only be said that in this limited experiment 20R:45UF performed as well. The slight apparent superiority of 20R:45UF could be due to random variations or it could be due to the fact that the working properties of 20R:45UF are superior to those of PR for a hot press cure of the type used in this experiment. Under hot press conditions the phenolic component of a PR resin causes a certain amount of thinning of the resin as heat is added. Since the glue line is already under pressure there is a possibility of a starved joint if the resin flows too much before it cures. Urea formaldehyde based resins don't display this thinning characteristic with added heat in the manner of the phenolics and hence for hot pressing or for radio frequency cure the urea family of resins has working properties superior to the phenolic types. This is particularly true for end joints where the absorbent endy grain in the joint makes them especially subject to the starved joint problem. Since the working characteristics are better and the cost lower the resorcinol urea (20R:45UF) seems to have certain advantages over the phenol resorcinol (PR) for finger joints cured by hot press or radio frequency.

The corner joints (all PR glue) seemed to have somewhat more glue failure after 9 years than the 4 end joints that proved durable (Table 1). This could either be due to the fact that the corner joint is a more demanding joint, or the fact that these joints were cold pressed and perhaps less adequately cured than the hot pressed end joints. The edge delamination was only measured on the outer tip of the corner joint. This outer tip,

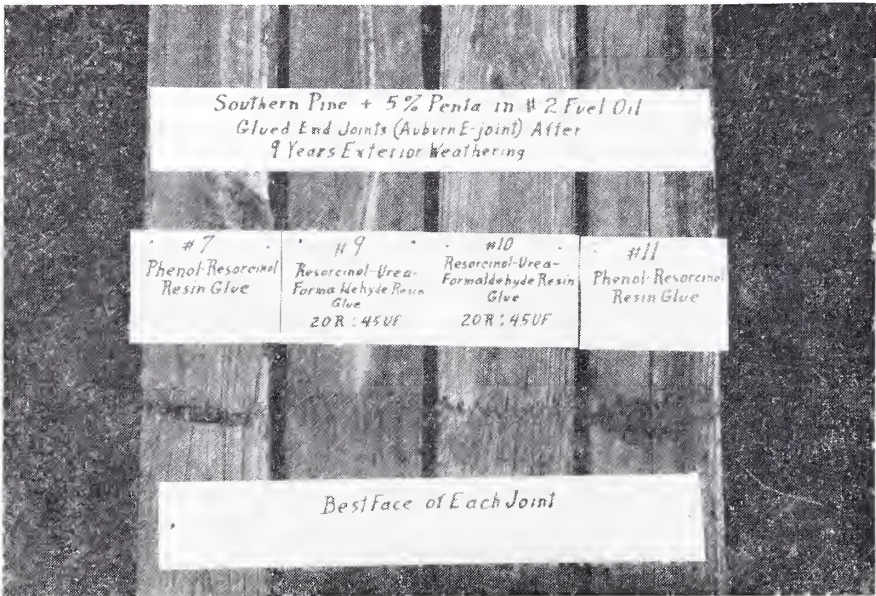


FIGURE 1. Condition of the best face of each of the 4 end joints that survived 9 years of exterior weathering at 32° 37' N. Latitude, 85½° W. Longitude.

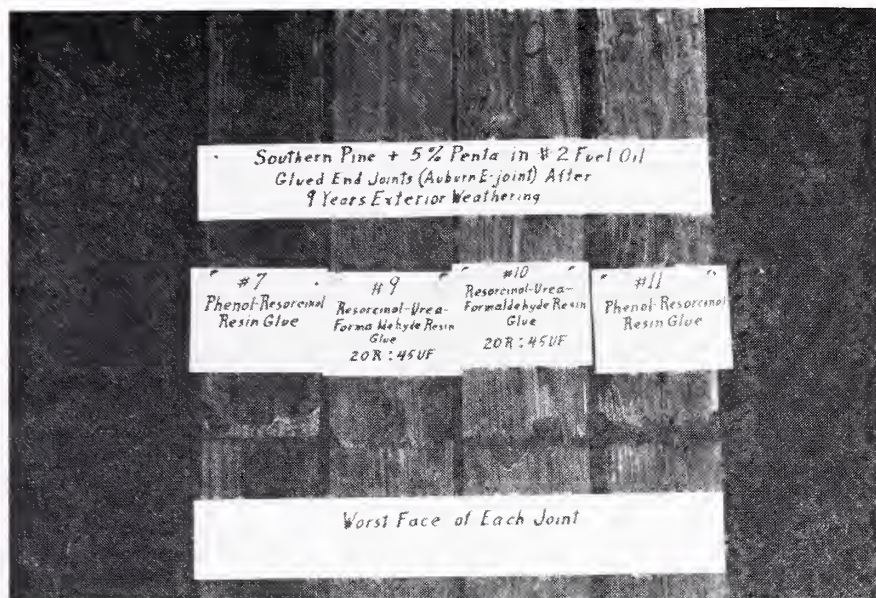


FIGURE 2. Condition of the worst face of each of the 4 end joints that survived 9 years of exterior weathering at  $32^{\circ}$   $37'$  N. Latitude,  $85\frac{1}{2}^{\circ}$  W. Longitude.

due to the end grain exposed, gains and loses water more readily and hence is cycled more violently than the edge of an end joint.

Since the interlocking fingers in these corner joints have their grain at  $60^{\circ}$  to each other, corner joints are perhaps a more demanding test for a glue than are end joints. Whether due to the greater demands of the corner joints or their less adequate glue cure, the corner joints showed 17 more percentage units of edge delamination and 19 more percentage units of outer slope glue failure than did the 4 durable end joints (Table 1). With the small number of specimens in this test these modest differences should not be overinterpreted. Since they do agree with what one might predict, however, it is felt that corner joints with the thin scarfed regions coming out to the surface of the joint might well be used as a demanding durability test for glues.

### CONCLUSIONS

Neither melamine formaldehyde nor a 5 to 3 blend with urea formaldehyde proved durable in southern pine end joints when exposed to outdoor weathering for 9 years at  $32^{\circ}$   $37'$  N. Lat.,  $85\frac{1}{2}^{\circ}$  W. Long. Phenol-resorcinol glue, and a urea formaldehyde strongly fortified with crystalline resorcinol (25R:45UF) proved durable to such exposure for 9 years. While still structurally sound,  $60^{\circ}$  corner joints glued with phenol-resorcinol glue showed somewhat more glue failure after 9 years than did the 4 durable end joints. If this difference should prove consistent it would suggest that fingered corner joints with a thin scarfed region at the surface might be used as a demanding durability test for glues.

## Woods For Stropping Razors

J. S. Dendy  
Zoology-Entomology Department  
Auburn University, Auburn, Alabama

### INTRODUCTION

The writer has sharpened knives and various other tools for more than 50 years, and for most of that period has honed and stropped his razors as needed for daily shaving. He has received instructions from various persons and from reading numerous accounts that described methods of sharpening tools varying from matchetes to microtome blades.

In the Philippines and in Brazil the fact that, after first using leather, barbers stropped razors on soft light wood to obtain extra fine cutting edges was observed with great interest. This information, along with results of tests of suitability of various woods for stropping razors, is presented with the hope that some persons may find woods useful in obtaining fine cutting edges and that the mild abrasive characteristics of certain woods may be exploited in other uses.

Personnel of the Forestry Department of Auburn University gave little encouragement regarding the possibility of finding references to the use of woods for stropping razors. No published account was found that referred to this use of woods. Possibly such references may be recorded obscurely in works on ethnological anthropology.

A casual comment in the middle 1930's by Mr. Phillips Verner (deceased), who lived for a while in Panama, indicated that balsa was used for stropping razors in that country. Several foreign students at Auburn University were questioned regarding use of woods for this purpose in their home countries. It was reported that barbers stropped razors on wood, at least in more rural areas, in Thailand, Pakistan, India, and Nepal. The Philippine Forest Products Research Institute, in a letter to Dr. B. Francis Kukachka of the United States Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin, stated that the wood used by barbers is a suffrutescent plant growing along streams, in swamps, and in shallow water lakes. It is known there by the name balakbak. The wood contains no silica or crystalline material of any kind.

### MATERIALS AND METHODS

Samples of several promising woods were obtained for testing their effectiveness in stropping razors. Pieces of balakbak approximately 1 x 1 x 8 in. (Figure 1) were purchased from a barber in Manila, Philippines. This wood was identified by the Philippine Forest Products Research Institute as being of the family Papilionaceae and in the species *Sesbania roxburghii* Merr. Pieces of rootwood from the Brazilian tree called timbauba were obtained from a market in Fortaleza, Ce., Brazil, in blocks approximately 2 x 2 x 12 in., prepared for use (Figure 2). Also Dr. Valdemar Franca, of Fortaleza, supplied a piece of freshly dug rootwood. Identification of this plant as *Enterolobium contortisillicum* Morong, of the family Leguminosae, was obtained by courtesy of Mr. Norris Gilbert in Fortaleza. Dr. Julian Dusi, of Auburn University, supplied rootwood of water tupelo,



*Nyssa aquatica* L. of the family Nyssaceae, from Dauphine Island, Alabama, because it had texture much like that of balakbak and dulled a knife rapidly when cut across the grain. Mr. Peter B. Mockridge, also of Auburn University, supplied rootwood of the pond-apple, *Annona glabra* L. of the family Annonaceae, from Roseland, Florida. A block of balsa, presumably *Ochroma ladopus* Swartz of the family Bombacaceae, which was selected as the softest of many pieces, was purchased from a local book store. A visit was made to Marion, Alabama, to study water tupelo trees and to obtain fresh samples of rootwood. No sizeable root growing completely submerged was available, but samples were taken of roots growing at or above the surface.

At least one smooth flat surface was prepared on each piece of wood to be tested. The initial test was made using balakbak. A razor was stropped on leather, 30 strokes on each side of the blade, and used for shaving. The following day the same razor was stropped on wood an equal number of strokes (the wood being about one half as long as the leather) and used for shaving. The razor was honed and then stropped on wood for daily shaving for a month or longer until further honing was needed. This wood was used for more than a year before other tests were conducted. For tests with other woods, the razor was re-honed and stropped on wood for daily use. Pocket knives and scalpels were sharpened on fine whetstones, tested, and stropped on wood, and then re-tested for sharpness. Woods have been used by the writer for stropping razors, pocket knives, and scalpels approximately 3000 times since the first piece of balakbak was obtained from a Philippine barber about 8 years ago.

## RESULTS

On the first test, balakbak proved to be so superior to leather that the latter was discarded. A sample of this wood was given to a barber in Auburn, Alabama, who reported that he was well pleased with its effectiveness in stropping razors.

The next wood tested was rootwood of water tupelo. Wood from submerged roots gave somewhat better results than did balakbak. The water tupelo seemed to be more resilient than the balakbak, and stropping produced a good cutting edge for longer periods between honings than did balakbak. The samples of wood from water tupelo roots that grew more or less exposed to air were too hard to produce good results when used for stropping razors.

Rootwood of pond-apple seemed to be equally as good as that of water tupelo. Stropping surface on the sample of water tupelo had an area of 11.7 sq. in., while the area of the pond-apple sample was only 6.5 sq. in. Since the smaller area produced results at least comparable to those of the larger area, the pond-apple was judged to be superior to the water tupelo. In addition, the pond-apple wood held together better than did the water tupelo, which tended to become stringy after several months of use.

The timbua block from Fortaleza sharpened the edge of a pocket knife when the blade was held at an angle rather than flat on the wood during stropping. A well honed razor responded to stropping on timbua and acquired an excellent cutting edge, but it required approximately twice as much stropping as would have been needed on pond-apple or water

tupelo. After several days of use the stropping became ineffective when the razor was held flat on the timbauba, but was satisfactory when the blade was positioned at a slight angle.



FIGURE 1. Stropping a razor on the Philippine wood balakbak.

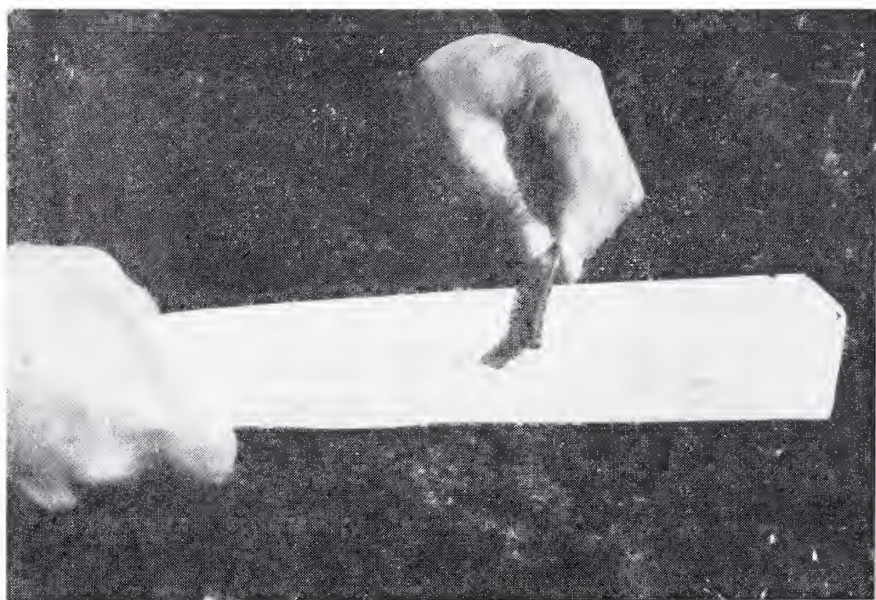


FIGURE 2. Stropping a razor on the Brazilian wood timbauba.

The block of soft balsa was much like that of timbauba. It produced an excellent edge for three or four uses, but after that the results were poorer. Both balsa and timbauba blocks were somewhat harder than the preferred woods and lacked resilience that seemed essential for producing good edges with repeated use between honings. After two or three months of daily stropping on resilient wood, more stropping was required to produce a good edge than was necessary immediately after honing. Examination with a magnifying glass revealed that there was a slight rounding of the blade at the edge. This gave evidence that the woods used had mild abrasive qualities.

Stropping polishes the blade on both sides of the edge, and does so at slightly greater angles than those produced by honing. Figure 3 illustrates how the strop produces this polishing effect on the extreme edge of the blade; diagram "A" by the angle of the leather, diagram "B" by the angle that results when resilient wood returns approximately to its normal position after being depressed by the blade, and diagram "C" by holding the blade at a slight angle when stropping on a non-resilient wood.

Because all tested woods were extremely light, it seems desirable to record their specific gravities. Dr. Evangelos J. Biblis, Forestry Department, Auburn University, determined the specific gravities (S. G. =  $\frac{\text{oven dried weight}}{\text{oven dried volume}}$ ) given below.

Pond apple submerged rootwood .....	0.085
Water tupelo submerged rootwood .....	0.090
Water tupelo exposed rootwood .....	0.127
Balakbak .....	0.124
Timbauba rootwood .....	0.114
Balsa .....	0.080

The specific gravities *per se* may not be related to the characteristics that make woods desirable as materials for strops, but they indicate other uses, especially as float materials. The use of balsa in rafts received much publicity

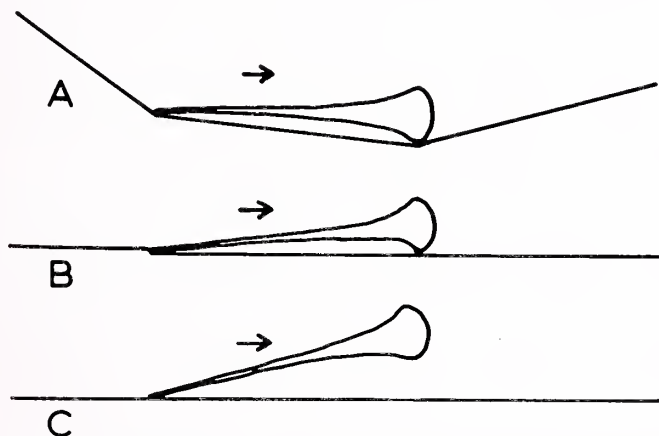


FIGURE 3. Diagrams illustrating the angle at which stropping polishes the surface on the side of the extreme edge of the blade of a razor; "A" on leather, "B" on soft resilient wood, and "C" on non-resilient wood.

in the widely read account of the voyage of the *Kon-Tiki* on the Pacific Ocean (2). The use of rootwood of timbauba as floats for fishing gear is common in Brazil. Harrar and Harrar (1) recorded that rootwood of water tupelo is occasionally employed as a substitute for cork.

### CONCLUSIONS

Submerged rootwoods of pond-apple and water tupelo were superior to other woods tested for stropping of razors. The Philippine wood known as balakbak was superior to leather. A soft sample of balsa wood and the rootwood of Brazilian timbauba were effective in stropping razors after adequate honing, but were not as good as pond-apple or water tupelo for continued use without honing.

The fact that certain woods have mild abrasive characteristics may lead to others uses than the stropping of razors and knives.

### LITERATURE CITED

1. Harrar, Ellwood S., and J. George Harrar. 1926. Guide to southern trees. Second Edition. Dover Publications, Inc. New York. 709 p.
2. Heyerdahl, Thor. 1953. *Kon-Tiki* across the Pacific by raft. Garden City Books. Garden City, N.Y. 218 p.



## A Laboratory Exercise With Seed Germination

Thomas Cochis and Kenneth Landers  
Department of Biology  
Jacksonville State University  
Jacksonville, Alabama

*Albizia julibrissin*, Durraz, (mimosa or silk-tree) seeds were gathered November, 1967 in Jacksonville, Alabama and stored until use, under refrigeration. On December 1, 1967 the seed were soaked for various durations of time in concentrated  $H_2SO_4$ , washed with water, and spread on damp filter paper which was placed in the bottom of Petri dishes, one dish for each treatment. The tops were placed on the Petri dishes, which were then allowed to stand at room temperature (70-75 F.). Treatments were replicated 3 times and 100 seed were used per treatment. Counts of seed germination were at 3 and 7 days. Any seed that had imbibed water and was swollen was considered germinated along with the obviously germinated seed.

The *Albizia* seed that received no treatment did not germinate under these conditions. Seed that were soaked in  $H_2SO_4$  for 1, 5, 10 and 15 min showed less than 10 percent germination, while those soaked 20 min showed 57 percent germination. The remaining treatments (25, 30, 45, and 60 min) showed germination above 95 percent (Table 1).

Germination counts were taken after 7 days at room temperature, although germination was nearly completed as early as 3 days after treatment. For all practical purposes, maximum germination was obtained after 20-25 minutes of soaking in  $H_2SO_4$ , with no increase in germination for the longer soaking durations.

Table 1. Percent germination of *Albizia julibrissin* seed at 7 days after scarification with concentrated  $H_2SO_4$ .

Reps	Time (min) seed were allowed to soak									
	0	1	5	10	15	20	25	30	45	60
1	0.0	5.0	7.0	5.0	5.0	62.0	97.0	99.0	95.0	99.0
2	0.0	3.0	0.0	0.0	17.0	52.0	99.0	98.0	99.0	96.0
3	0.0	3.0	0.0	0.0	7.0	58.0	100.0	92.0	94.0	91.0
Ave.	0.0	3.6	2.3	1.6	9.6	57.3	98.6	96.3	96.0	95.3

Use of chemical scarification for silk tree seed is well known<sup>1</sup>. The purpose of this paper was not to present original results but to show how this procedure might be used as a laboratory exercise in a General Biology or General Botany class.

The seed is readily available in most areas and most schools already possess the additional supplies needed. The experiment is easily done in a 2 hr laboratory period, with results being available the following period. The results are repeatable and dependable. For classroom adaptation the number of replications and seed per treatment may be reduced.

<sup>1</sup>Hartmann, H. T. and D. E. Kester. 1964. Plant Propagation: Principles and Practices. Prentice-Hall Pub. Co., Englewood Cliff, N.Y.

# Intrinsic Strain Broadening In The EPR And UPR Spectrum Of $\text{CaF}_2:\text{U}^{4+}$ In Trigonal Sites

Charles M. Bowden and Perry F. McDonald  
U.S. Army Missile Command, Redstone Arsenal, Alabama

The effective spin one Hamiltonian describing the interaction of the  $\text{U}^{4+}$  ions with the crystalline electrostatic field and applied magnetic field  $H_0$  is given as

$$H = g\|\beta H_z S_z + \delta [S_z^2 - \frac{1}{3} S(S+1)] + \underline{S} \cdot \underline{D} \cdot \underline{S}, \quad (1)$$

where the last term is added in order to account for perturbations to the purely trigonal crystal field symmetry by the presence of localized intrinsic strains.

For a particular ion, the elements of the D tensor are written in terms of linear combinations of the strains,  $\epsilon_{ij}$ , i.e., ~

$$D_{ij} = \sum_{k,l} G_{ijkl} \epsilon_{kl} \quad (2)$$

Noting that  $T_r D$  is not an observable and thus setting it equal to zero, and demanding time inversion symmetry, the contribution to the spin Hamiltonian arising from strain is

$$\begin{aligned} H_S = & \frac{1}{4} D_{11} [S_- S_+ + S_+ S_-] + \frac{1}{4} D_{22} [S_- S_+ + S_+ S_-] + D_{33} S_z^2 \\ & + \frac{1}{4} [D_{11} - D_{22} - 2i D_{12}] S_+^2 + \frac{1}{4} [D_{11} - D_{22} + 2i D_{12}] S_-^2 \\ & + \frac{1}{2} [D_{13} - i D_{23}] [S_+ S_3 + S_3 S_+] + \frac{1}{2} [D_{13} + i D_{23}] [S_- S_3 \\ & + S_3 S_-] \end{aligned} \quad (3)$$

This can be written more compactly as

$$H_S = H_D + \Delta S_+^2 + \Delta^* S_-^2 + \Delta' (S_+ S_3 + S_3 S_+) + \Delta'^* (S_- S_3 + S_3 S_-) \quad (4)$$

where  $H_D$  is the part of  $H_S$  which yields only diagonal matrix elements and

$$\Delta = \frac{1}{4} [(D_{11} - D_{22}) - 2i D_{12}] ; \Delta' = \frac{1}{2} [D_{13} - i D_{23}] \quad (5)$$

Treating the third term in (1) as a perturbation, the energy eigen-values are, to second order

$$E_+ = g\|\beta H_z + \frac{1}{3} \delta + \frac{4\Delta^2}{\epsilon_+ - \epsilon_-} + \frac{2\Delta'^2}{\epsilon_+ - \epsilon_0} \quad (6)$$

$$E_- = -g\|\beta H_z + \frac{1}{3} \delta + \frac{4\Delta^2}{\epsilon_- - \epsilon_+} - \frac{2\Delta'^2}{\epsilon_- - \epsilon_0} \quad (7)$$

$$E_0 = -\frac{2}{3} \delta + \frac{2\Delta'^2}{\epsilon_0 - \epsilon_+} - \frac{2\Delta'^2}{\epsilon_0 - \epsilon_-} \quad (8)$$

For a resonance experiment at x-band only the transitions  $\Delta M_s = \pm 2$  are observed<sup>1</sup>. Also, spin relaxation measurements show that  $\delta$  is on the order of  $5 \text{ cm}^{-1}$  or more<sup>2</sup>. The resonance condition to second order is therefore

$$h\nu = 2g\beta H_z + \frac{8\Delta^2}{h\nu} \quad (9)$$

The first term in (9) is just the unperturbed Zeeman splitting and the second term is always positive. The effect of strains is to increase the separation of the levels thus making the lines sharp on the low energy side and broadened on the high energy side. The observed line shape for  $\text{CaF}_2:\text{U}^{4+}$  illustrates this effect.

Since the observed line widths are fairly broad (approx. 10 gauss) the shape is dependent to a large extent upon the function

$$f(E) = \frac{8 D(\Delta)}{h\nu} \quad (10)$$

where  $D(\Delta)$  is the distribution in  $\Delta$  for spins having a set of strains corresponding to an energy  $E$ . The line shape is calculated, using a computer program, and the dependence of the intensity distribution on the random strains is<sup>3</sup>

$$I(E) = \int |\langle q | H_d | l \rangle|^2 \delta(E - E') P(E') dE' \quad (11)$$

where  $|\langle q | H_d | l \rangle|^2$  is the matrix element of the driving term and  $P(E')$  is the probability distribution for the system corresponding to sets of strain combinations which give rise to the energy  $E$ . This distribution is given by

$$P(e) = \int \delta(E - E') \prod_i p_i(\epsilon_i) d\epsilon_i \quad (12)$$

where the  $p_i(\epsilon_i)$  are Gaussian distributions in the strains  $\epsilon_i$ .

<sup>1</sup> Meyer, H. C., McDonald, P. F., Donoho, P. L. (unpublished).

<sup>2</sup> Hartman, R. L. and Wilkinson, E. L. (unpublished).

<sup>3</sup> McMahon, D. H. 1964. Physics. Rev. 134: 128.









5.06(761)JS

# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

VOLUME 40

APRIL, 1969

NUMBER 2

LIBRARY  
OF THE  
AMERICAN MUSEUM  
OF NATURAL HISTORY



# THE JOURNAL OF THE ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 40

APRIL, 1969

NUMBER 2

## EDITOR

Robert T. Gudauskas  
Auburn University

## ARCHIVIST

Clyde H. Cantrell  
Auburn University

## EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Paul H. Nesbitt  
Maxwell AFB  
Montgomery

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of the Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

# Contents

## ARTICLES

Nearly Free Electron Wave Functions and Band Gap Parameters in bcc Crystals Howard J. Foster and Paul H. E. Meijer.....	71
Life History Study of the River Redhorse in the Cahaba River, Alabama Peter A. Hackney, Walter M. Tatum, and Sam L. Spencer.....	81
Experiments with Ferrocene Samuel P. McManus .....	90
Reactions of Formamide with Fenton's Reagent and Hydrogen Chloride R. C. Sheridan and W. D. Willhide.....	93
The Montgomery Papers Sandor Szilassy.....	96
Notional Frontiers of Environment Earl P. Clere.....	103
Did the New Economics Fail in 1967? Keith Bryant, Jr.....	105
Retail Store Patronage Decisions Among College-Age Negroes James C. Carroll.....	109
Opportunities for Teaching Science Abroad and the Values Derived Ann Lucas.....	113
Helping Academic Failures to Succeed in Science J. Edward Griffith and Hollis C. Fenn.....	115
Approach to Physical Science for Upward Bound Students at the Alabama A and M College Hayward O. Handy .....	119
An Improved Cycle-Counting Technique for Zone Refining Systems Donald L. Gumprecht.....	121
Half-Fertile — Half-Sterile Leaf of <i>Woodwardia arcolata</i> Billy J. Williams .....	123

# Nearly Free Electron Wave Functions And Band Gap Parameters In bcc Crystals

Howard J. Foster

Department of Physics and Mathematics

Alabama A&M University, Huntsville;

and Physical Sciences Laboratory, Redstone Arsenal, Alabama

and

Paul H. E. Meijer

The Catholic University of America, Washington, D. C.

## INTRODUCTION

The application of group theory to the quantum mechanics of crystalline structures has always had a large appeal among physicists and mathematicians. Group theoretical methods are helpful in making the formal aspects of quantum theory more plausible and provide a short cut in the calculations, particularly in the quantum theory of crystalline solids. As a result, one finds in the literature a steady increase in the number of papers with applications of the theory of representations.

Group theoretical methods can be employed in the solution of problems in physics which fall into two main categories, both of which are characterized by regularities in the physical properties that one seeks to explore. One case is that in which symmetry considerations of group theory can be applied to reduce the elements of the stress-strain (Hooke's law) matrix, the heat conduction and the piezoelectric tensors in a crystal (11). Another is the use of group theory to facilitate the construction of wave functions which are needed to calculate the expectation values of position, momentum, energy and other observables in the electron-crystal system (10, 12). In each case group theoretical methods are helpful in reducing the complexity and the labor which would otherwise be required in the calculations of the physical properties of the solid, and in the last case they are able to predict the degree of degeneracy of the energy levels. This is the result of the fact that the differential equations describing the system and boundary conditions are of such a geometrical nature that transformations (rotations and translations) of the electron wave functions leave the problem unchanged.

We chose to investigate the case for the body-centered cubic (bcc) crystals which have a simple theoretical model. The alkali metals which have nearly free electrons fall into this category.

Recall that the bcc structure of the alkali metals in real space coordinates corresponds to the face-centered cubic (fcc) lattice in  $k$ -space (7, 9). The first Brillouin zone (BZ) constructed from the fcc reciprocal lattice is a rhombic dodecahedron (2). The theory is further simplified by considering certain points of spatial symmetry only in the neighborhood of the zone boundary.

Electronic band structure calculations for all of the alkali metals have been carried out by Ham (5) using quantum defect and Green's function methods. In a separate paper, Ham (6) has evaluated the Fermi surface and other related parameters of the alkali metals with the help of an interpolation scheme in the nearly free electron approximation. Heine and Abarenkov (8) have used a screened ion potential in constructing electron wave functions and have obtained band gap energies for potassium in close agreement with those calculated by Ham.

The aim of this paper is to illustrate the capability of group theory in predicting the degeneracy of the electron wave functions and the magnitudes of band gap energies with the help of geometrical models of the Brillouin zones in the nearly free electron approximation. It is mainly in the use of pictorial models of the BZ to construct the electron wave functions that this paper differs from other treatments of this problem. Although the calculations will apply to all of the alkali metals, we shall restrict our attention to the alkali metal potassium in the discussion of the results.

### ELEMENTARY CONSIDERATIONS

For the total system, i.e., the crystal composed of ions at rest and electrons, one assumes that a set of stationary states exists for any one electron in the lattice and that all the electrons are distributed among these states according to Fermi-Dirac statistics. One therefore seeks the propagating solutions of the familiar Schrödinger equation, neglecting electron-electron (Coulomb) interaction, in the one electron approximation:

$$\left[ \nabla^2 + \frac{2m}{\hbar^2} \left\{ E - V(\mathbf{r}) \right\} \right] \psi(\mathbf{r}) = 0 \quad (1)$$

subject to the usual boundary conditions imposed by the periodic potential  $V(\mathbf{r})$  which arises from the electric fields of the ionic lattice. A Fourier series representation for the potential,

$$V(\mathbf{r}) = \sum_{\mathbf{k}=0}^n V_{\mathbf{k}} \exp(i\mathbf{G}_{\mathbf{k}} \cdot \mathbf{r}) \quad (2)$$

has been found to apply quite satisfactorily for some metals, e.g., the alkalis (6) even if only a small number of terms is retained. The series expression for  $V(\mathbf{r})$  is truncated in this case only because the electrons are known to move virtually uninhibited throughout the crystal with very little interaction with the ions. In Eq. (2),  $\mathbf{G}$  is the reciprocal lattice vector, pointing from the nearest face of the BZ to the opposite face. The shape of the wave functions will of course depend on the electron-ion interactions as described by the lattice potential.

The existence of gaps in the electronic energy spectrum of a periodic lattice structure is due to the fact that the wave functions are degenerate at the BZ boundary and nearly degenerate near the BZ boundary. If one mixes two free electron states by employing a Fourier coefficient of the lattice potential as an interaction operator, the electron undergoes a Bragg-like reflection at the BZ surface. This causes a distortion of the electronic energy surface from its free electron form.

In considering the problem of degeneracy or near degeneracy, one has to diagonalize a secular matrix in order to determine the new linear combination of wave functions. The fundamental basis for these considerations is always the Bloch theorem (1).

### CONSTRUCTION OF THE WAVE FUNCTIONS

The mathematical notation and symbols which appear in the quantum mechanical-group theoretical derivations to follow, have their usual significance as described, for example, by Jones (9) and Calaway (3).



In order to construct the number of wave functions necessary for describing the states on each of the three high symmetry axes, [110], [111], and [100] within the BZ for bcc potassium crystal, it is convenient to examine geometrical models of the BZ which correspond to the fcc reciprocal lattice. The problem is simplified by using s-wave functions only to predict the degeneracies in the three levels at the BZ boundary.

Consider the [110] direction, as illustrated in Figure 1, in which there are two nearly degenerate wave functions. To be specific, take the wave function with the  $k$  vector at the point A, just inside the BZ surface. The point of intersection of the [110] axis with the BZ surface is usually called N. This wave function is nearly degenerate with the wave function that has its  $k$  vector at B, which is on the [110] axis at the same distance from the origin as A. We will "reduce" the wave function at B to the point B' and express the two wave functions, having  $k$  vectors at A and B, with the help of a wave vector  $\kappa$  relative to N:  $\kappa = k_N - k$ . Explicitly, we have

$$\begin{aligned} \text{At A: } \psi_1(\kappa) &= \exp(i k_N \cdot x - i \kappa \cdot x) \\ \text{At B: } \psi_2(\kappa) &= \exp(-i k_N \cdot x + i \kappa \cdot x) \\ \text{At B': } \psi_2(\kappa) &= \exp(i k_N \cdot x + i G \cdot x + i \kappa \cdot x) = \exp(i k_N \cdot x + i \kappa \cdot x) \\ k_N &= \frac{2\pi}{a} (\frac{1}{2}, \frac{1}{2}, 0); G_N = \frac{2\pi}{a} (\pm 1, \pm 1, 0); -k_N + G_N = k_N \cdot \end{aligned} \quad (3)$$

We find that the two wave functions, associated with the points A and B, have opposite  $\kappa$  vectors.

Let us consider the transformation properties of these two wave functions with respect to the point N. The type of symmetry of the point will lead to a group, and given the group, one can find its irreducible representations. If the irreducible representation of the wave function is known, one can predict the degeneracy, if any, from the dimensionality of the irreducible representation. The point group of the point N is called  $mmm$  or  $D_{2h}$ . It has 8 elements and is Abelian. The character table is given, for instance, by Jones (9), and we will use his choice of notation for the 8 irreducible representations.

If we consider the wave functions  $\psi_1$  and  $\psi_2$ , we find that upon reflection with respect to the line BZ,  $\psi_1 \rightarrow \psi_2$  and  $\psi_2 \rightarrow \psi_1$ . This leads to a two-dimensional representation which should be reducible. The basis for the irreducible representation is

$$\begin{aligned} \psi'_1 &= \psi_1 + \psi_2; & \psi'_1 &\rightarrow \psi'_1 \\ \psi'_2 &= \psi_1 - \psi_2; & \psi'_2 &\rightarrow -\psi'_2 \end{aligned} \quad (4)$$

On comparing the other operations of  $D_{2h}$  with the character table, we find that

$\psi'_1$  belongs to the irreducible representation  $N_1$ , and that  
 $\psi'_2$  belongs to the irreducible representation  $N'_1$ .

Let us now consider the point P, at the intersection of three faces on the BZ boundary in the [111] direction. For simplicity, we construct neighbor-



with the  $\kappa$  vectors parallel to the cube diagonals. The symmetry around P is  $T_d$  or  $\tilde{43m}$ ; the wave functions, each with one of the four  $\kappa$  vectors, form a four-dimensional reducible representation. It is easy to guess the irreducible components: take

$$\psi'_0 = \frac{1}{2} (\psi_0 + \psi_1 + \psi_2 + \psi_3) \quad (8)$$

This is an invariant and hence corresponds to the representation  $P_1$ . Further, we have

$$\begin{aligned} \psi'_1 &= \frac{1}{2} (-\psi_0 - \psi_1 + \psi_2 + \psi_3) \\ \psi'_2 &= \frac{1}{2} (-\psi_0 + \psi_1 - \psi_2 + \psi_3) \\ \psi_3 &= \frac{1}{2} (-\psi_0 + \psi_1 + \psi_2 - \psi_3) \end{aligned} \quad (9)$$

which will mutually transform like  $(x, y, z)$  and this corresponds to the representation  $P_4$ . In general,  $P_1$  will belong to the higher level; the three fold degenerate level  $P_4$  will correspond to the lower level. The coefficients ( $\frac{1}{2}$ ) are chosen so that the wave functions form an orthonormal set.

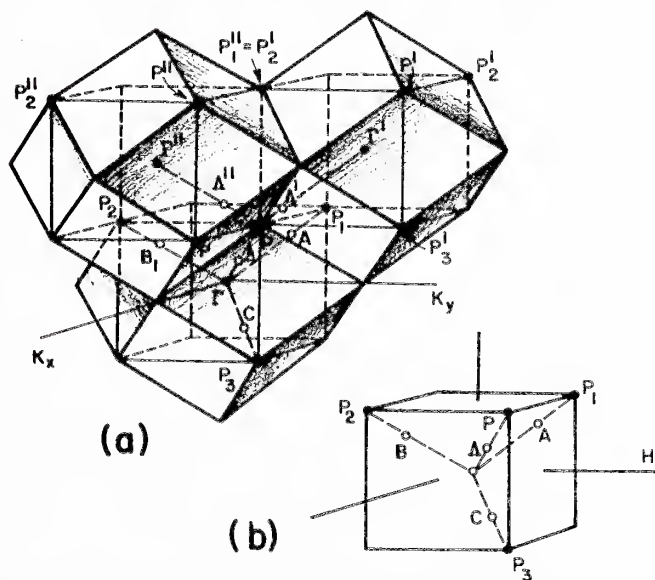


FIGURE 2. (a) Cubes inscribed within neighboring BZ's for the bcc space lattice to illustrate the connectivity and periodicity of the point P at the BZ faces in the (111) direction. The point  $\Lambda$  on  $\Gamma P$  is equivalent to the points  $\Lambda'$  on  $\Gamma'P$  and  $\Lambda''$  on  $\Gamma''P$  (shown), and to the point  $\Lambda'''$  on the body diagonal of the inscribed cube within the lowest forward BZ (not shown). In (b) the cube is lifted out of the BZ for clarity of the labels on the (111) diagonals.

The point H in the [001] direction, or the equivalent thereof, is a point of octahedral symmetry. If one allows the point  $\Delta$  to approach H, one finds that there are four points that are connected by the proper Fourier component,  $V_{\tilde{G}}$ , of the lattice potential. From Figure 3, one finds that there are six neighboring BZ's which have the point  $H_1$  in common, corresponding to the zero component of  $\tilde{G}$ . Any two of the 24 nearest neighbor points to  $H_1$ , 4 for each

BZ, can be connected by one of the appropriate  $\tilde{G}$  vectors:  $\frac{2\pi}{a} (\pm 2, 0, 0)$ ,  $\frac{2\pi}{a} (0, \pm 2, 0)$ ,  $\frac{2\pi}{a} (0, 0, \pm 2)$ , which satisfies the Bragg condition at  $H_1$ .

In order to determine the degeneracy in the point H, we calculate the character of this reducible representation. This is done by writing down the permutations of the six axes, which leads to a matrix having only 1's and 0's (only one number one per row and per column). Hence, the character is given by

- $\chi = 0$  for rotations around the face diagonal and the body diagonal.
- $\chi = 2$  for rotations around an edge, through the angles  $\pi$  and  $\pi/2$ .
- $\chi = 6$  for the unit element.

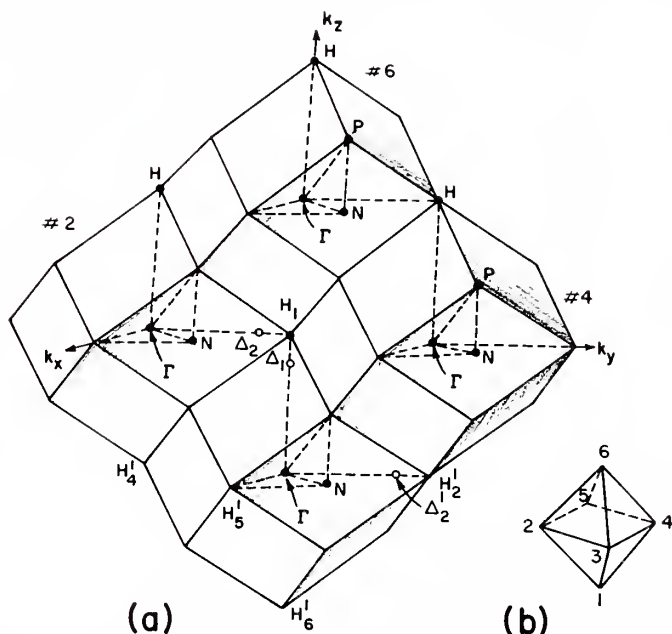


FIGURE 3. (a) Stacked BZ's for the bcc space lattice to show the connectivity and symmetry properties in the (100) direction, and (b) to show the connectivity of the wave functions and the degeneracy of the states at the point H on the BZ surface in the (100) direction. In (a), the point  $H_1$  on top of the lowest BZ is shown with three of its neighboring BZ's out of the five that are possible. The wave function with  $k$  value coming down from # 6 is not *directly* connected with #1, as illustrated in (b).

Upon comparison with the character table for the cubic group in Calaway (3), one finds that this representation contains  $H_1$ ,  $H_{12}$ , and  $H_{15}$ , respectively. One can show that the linear combinations are given by (section IV):

$$H_1: \psi_3 + \psi_5 - (\psi_1 + \psi_6 + \psi_2 + \psi_4) \quad (10)$$

$$H_{12}: \begin{aligned} &\psi_1 + \psi_6 - \psi_2 - \psi_4 \\ &\psi_1 + \psi_6 + \psi_2 + \psi_4 + \frac{1}{2}(\psi_3 + \psi_5). \end{aligned} \quad (11)$$

$$H_{15}: \begin{aligned} &\psi_1 - \psi_6 \\ &\psi_2 - \psi_4 \\ &\psi_3 - \psi_5 \end{aligned} \quad (12)$$

The points,  $H'_2$ ,  $H'_4$ ,  $H'_5$ ,  $H'_6$  (indicated), and the point  $H'_3$  (not shown), have energies degenerate with  $H_1$ , or nearly degenerate with  $\Delta_1$ . The interaction potential  $V_1$  will split this six-fold degeneracy into three levels, which remain one, two, and three-fold degenerate.

### BAND-GAP ENERGY CALCULATIONS

The parameters which describe the band-gap energies at the BZ boundaries along the [110], [111], and [100] directions will now be calculated with the help of the wave functions constructed in the previous section.

For the determination of the band gap at the surface of the BZ in the [110] direction, we shall need the wave functions as described in expressions (3) and (4). Simple arithmetic shows that  $N_1$  lies higher than  $N'_1$ ; that is,

$$(\psi_1 + \psi_2|H|\psi_1 + \psi_2) = H_{11} + H_{12} + H_{21} + H_{22} \quad (13)$$

is greater than

$$(\psi_1 + \psi_2|H|\psi_1 - \psi_2) = H_{11} - H_{12} - H_{21} + H_{22} \quad (14)$$

at least if  $H_{12}$  is positive. Indeed, if one calculates the secular determinant from

$$\begin{vmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{vmatrix} = \begin{vmatrix} V_0 & V_1 \\ V_1 & V_0 \end{vmatrix} \quad (15)$$

where  $V_0$  is the zero Fourier component of the lattice potential and  $V_1$  is the Fourier component corresponding to  $G$ , one finds that the sum (cosine-like wave functions) and the difference (sine-like wave functions) are the proper basis functions. Upon diagonalization of the matrix (15), one finds, from the two single eigenvalues  $V_0 + V_1$  and  $V_0 - V_1$ , that the band gap parameter in the [110] direction at the BZ surface is  $2 V_1$ . This does not differ from the one dimensional case.

On the [111] axis the  $k$  vector is equidistant from three faces of the BZ surface. (Refer to Fig. 2.) For the calculation of the band gap energy at the BZ boundary along [111], we shall need the wave functions in (8) and (9), in order to connect the gap parameter with the relevant Fourier components of the potential. The wave function at  $P$  and its equivalent points have a diagonal matrix element

$$(\psi_i|H|\psi_i) = V_0; i = 0, 1, 2, 3. \quad (16)$$

The wave functions between P and either of the points  $P_1$ ,  $P_2$ , and  $P_3$ , give the same matrix element, that is,

$$(\psi_0|H|\psi_i) = V_1; i = 1, 2, 3 \quad (17)$$

where  $V_1$  is the Fourier coefficient corresponding to the reciprocal lattice vector  $\tilde{G}$ . The important thing to notice is that the matrix elements between  $P_1$  and  $P_2$ ,  $P_2$  and  $P_3$ , and  $P_3$  and  $P_1$  have the same value, because the distance in reciprocal space between these points is the same. Hence, the matrix is

$$H = \begin{bmatrix} V_0 & V_1 & V_1 & V_1 \\ V_1 & V_0 & V_1 & V_1 \\ V_1 & V_1 & V_0 & V_1 \\ V_1 & V_1 & V_1 & V_0 \end{bmatrix} \quad (18)$$

From the wave functions in (8) and (9), we know that this matrix is diagonalized by the similarity transformation

$$S = \frac{1}{2} \begin{bmatrix} 1 & 1 & 1 & 1 \\ -1 & -1 & 1 & 1 \\ 1 & 1 & -1 & 1 \\ -1 & 1 & 1 & -1 \end{bmatrix} \quad (19)$$

The diagonalized matrix gives the result  $V_0 + 3V_1$  for the single eigenvalue and  $V_0 - V_1$  for the triple eigenvalue. From this, the energy gap is  $4V_1$ , with the single eigenvalue lying higher than the value corresponding to the three dimensional representation  $P_4$ , again assuming that the matrix elements are positive.

Along the  $[100]$  axis within the BZ the wave vector  $\tilde{k}$  is equidistant from four faces at the BZ boundary. (Refer to Fig. 3) Again, the periodic perturbing potential mixes only the states of differing reciprocal lattice vector  $\tilde{G}$  within the zone. The Fourier components of the potential are simply  $V_0$  and  $V_1$  as before. From the dimensionality of the irreducible representations already given in (10), (11), and (12) for this case, one should expect a single, a two-fold, and a three-fold degenerate level at H where  $|\tilde{k}| = \frac{1}{2} |\tilde{G}|$ .

The secular determinant is given by

$$\begin{vmatrix} \lambda/V_1 & 0 & 1 & 1 & 1 & 1 \\ 0 & \lambda/V_1 & 1 & 1 & 1 & 1 \\ 1 & 1 & \lambda/V_1 & 0 & 1 & 1 \\ 1 & 1 & 0 & \lambda/V_1 & 1 & 1 \\ 1 & 1 & 1 & 1 & \lambda/V_1 & 0 \\ 1 & 1 & 1 & 1 & 0 & \lambda/V_1 \end{vmatrix} = 0 \quad (20)$$

The rows and columns are labeled in the order 1, 6, 2, 4, 3, and 5 to obtain an esthetically appealing form. If we take the sum and difference for the even



and odd rows and columns we find  $\lambda = 0$  (3 times, for the differences: (1 - 6); (2 - 4); (3 - 5))

$$\text{and } \begin{vmatrix} \lambda/V_1 & 2 & 2 \\ 2 & \lambda/V_1 & 2 \\ 2 & 2 & \lambda/V_1 \end{vmatrix} = 0 \text{ for the sum: } (1 + 6); (2 + 4); (3 + 5) \quad (21)$$

If we take the sum and difference of the first and second row and column, we find

$$\begin{vmatrix} 2(\lambda/V_1 + 2) & 4 \\ 4 & \lambda/V_1 \end{vmatrix} = 0 \quad \begin{matrix} (1 + 6) + (2 + 4) \\ (3 + 5) \end{matrix} \quad (22)$$

and

$$\lambda = 2V_1 \text{ for } (1 + 6) - (2 + 4). \quad (23)$$

The secular determinant (22) has two roots:  $\lambda = 2V_1$  and  $\lambda = -4V_1$ . The first belongs to the wave function

$$(1 + 6 + 2 + 4) - \frac{1}{2} (3 + 5)$$

which is degenerate with (23) and describes the two dimensional representation  $H_{12}$ ; the second is the nondegenerate wave function belonging to  $H_1$ :

$$(3 + 5) - (1 + 6 + 2 + 4).$$

The energy levels at H are given by

$$H_{12}: \lambda = 2V_1; H_{15}: \lambda = 0; H_1: \lambda = -4V_1.$$

To determine the effective  $V_1$ , Hamm uses the gap between  $H_1$  and  $H_{12}$ . The parameter  $V_1$  seems to be negative. On the basis of this simple calculation with s-wave functions, the position of  $H_{15}$  is higher than expected.

### SUMMARY

To obtain a first approximation for the splitting of the bands at a symmetry point in k-space, we introduce a secular matrix. The dimensionality of this matrix is, for s-wave functions, equal to the number of BZ's meeting in that particular point as illustrated in the paper. (For waves of higher angular momentum, the dimensionality of the secular matrix is  $(2l + 1)$  times the number of BZ's meeting in that point.) By means of group theory one can deduce a priori the irreducible representation to which the basis functions will belong and hence the degeneracy of the energy surfaces at the symmetry point. The basis functions were calculated directly from the secular determinant.

If one uses the theoretical values of the Fourier coefficients as determined by Ham (6), who also predicted a nearly spherical Fermi surface of potassium in close agreement with our experimental determination (4), one finds the magnitudes of the band gap energies at the BZ boundaries in potassium as indicated:

$$\Delta E(N) = 2V_1 = -0.032$$

$$\Delta E(P) = 4V_1 = 0.080$$

$$\Delta E(H) = 6V_1 = 0.234$$

The band gap energies are in Rydberg units using for the value of the potassium lattice constant  $a = 10.05$  atomic units.

#### ACKNOWLEDGEMENT

The authors wish to express sincere thanks to members of the Solid State Theory group of the Physical Sciences Laboratory, Redstone Arsenal, for helpful comments.

#### LITERATURE CITED

1. Bloch, F. 1928. *Z. Physik* 52: 555.
2. Bouckaert, L. P., R. Smoluchowski, and E. Wigner. 1936. *Phys. Rev.* 50: 58.
3. Calaway, J. 1964. *Energy Band Theory*. Academic Press, New York.
4. Foster H., P. H. E. Meijer, and E. Mielczarek. 1965. *Phys. Rev.* 139: A1849.
5. Ham, F. S. 1962. *Phys. Rev.* 128: 82.
6. Ham, F. S. 1962. *Phys. Rev.* 128: 2524.
7. Heine, V. 1960. *Group Theory in Quantum Mechanics*. The Macmillan Co., New York.
8. Heine, V., and I. Abarenkov. *Phil. Mag.* 9: 451.
9. Jones, H. 1960. *The Theory of Brillouin Zones and Electronic States in Crystals*. North-Holland Publishing Co., Amsterdam.
10. Landau, L. D., and E. M. Lifshitz. 1958. *Quantum Mechanics*. Addison-Wesley Publishing Co., Inc., Reading, Mass.
11. Mason, W. P. 1950. *Piezoelectric Crystals and Their Application to Ultrasonics*. D. Van Nostrand Co., Inc., New York.
12. Meijer, P. H. E. and E. Bauer. 1962. *Group Theory, the Application to Quantum Mechanics*. John Wiley and Sons, Inc., New York.

# Life History Study Of The River Redhorse, *Moxostoma carinatum* (Cope), In The Cahaba River, Alabama, With Notes On The Management Of The Species As A Sport Fish

Peter A. Hackney, Walter M. Tatum, and Sam L. Spencer  
Alabama Department of Conservation  
Montgomery, Alabama

## INTRODUCTION

From a review of the literature it is apparent that relatively little is known about the river redhorse, *Moxostoma carinatum* (Cope). Most of the work conducted with this species is concerned with identification and occurrence.

Severe reduction in numbers or extirpation of the river redhorse from areas of former abundance has been noted by several authors (3, 5, 7). This trend is also occurring in Alabama. The species has constituted as high as 24.3 percent of the total weight of fish collected in rotenone samples of Alabama streams<sup>1</sup>. They have not been recorded in similar studies of these same areas following impoundment and inundation of the river habitat <sup>2,3</sup>. Although reliable records of earlier abundance are generally lacking for many areas of Alabama, it is apparent that the river redhorse has suffered severe reduction in numbers and possible extirpation over much of its former range within the state. One exception is the Cahaba River where the species is still found in abundance.

The river redhorse has fine potential as a sport fish because of its relatively large size, palatability, and stamina. It was felt that there was need for more knowledge of this disappearing redhorse before initiating any greatly increased exploitation. The Cahaba River offered an excellent opportunity for study of this fish.

## DESCRIPTION OF STUDY AREA

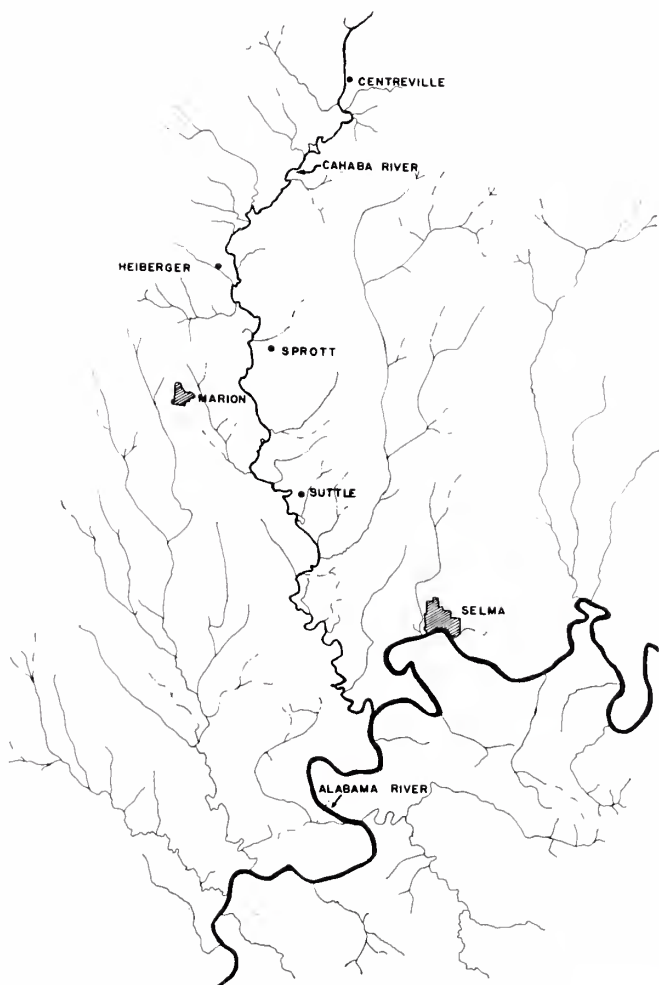
The study area for this project was the Cahaba River in the central portion of Alabama. The headwaters of the Cahaba River are located in the northeastern portion of Jefferson County near Birmingham, Alabama. The river flows in a southwesterly direction and joins the Alabama River near Selma, Alabama (Fig. 1). The Cahaba River Basin comprises approximately 1,870 sq. mi. The 27 year average flow at Sprott, Alabama is 2,053 cubic ft. per sec. with a maximum recorded flow of 95,000 cubic ft. per sec. A minimum flow of 188 cubic ft. per sec. was recorded on October 25 and 26, 1954.

The river exhibits considerable gradient with long pools broken by rapids or shoals. The shoals above Suttle, Alabama are composed of rocks and gravel. Below Suttle, shoals are less numerous and consist mainly of gravel and sand. Submersed aquatic vegetation is absent and marginal aquatics are scarce.

<sup>1</sup> Alabama Department of Conservation, Report for Fiscal Year October 1, 1957-September 30, 1958. p. 134.

<sup>2</sup> Ibid. October 1, 1962 - September 30, 1963. pp. 110-111.

<sup>3</sup> Ibid. October 1, 1963 - September 30, 1964. pp. 119-120.



Except for a 1,000 acre water supply reservoir located in the extreme headwaters and a very small amount of pollution, the river has been relatively unaffected by man's activity.

## METHODS

### *Collecting River Redhorse*

River redhorse were captured with a boat mounted electric shocker. Electric current was provided by a 110-220 v alternator (Sears, Roebuck and Company) with a rated capacity of 2,650 w. Output was controlled with a Model II-C, Variable Voltage Pulsator manufactured by Coffelt Electronics Company, Denver, Colorado.



FIGURE 2. Tagging river redhorse.

The electric shocking equipment was mounted on a flat-bottom 16-foot Monarc boat. Two weighted flexible electrodes were mounted 14 ft. in front of the boat and approximately 10 ft. apart.

A voltage range from 150 to 300 v A.C. at 3 to 4 amp was effective for capturing this species. Fish were picked up with large hoop dip nets fitted with 8-ft. aluminum reinforced fiberglass handles. Immediately upon capture, fish were placed into the boat live well and aeration was provided by a compressed oxygen cylinder and regulator. After the live well capacity was reached the fish were weighed to the nearest 0.01 lb, measured to the nearest 0.1 in., sexed and tagged. The fish were then returned to the river and the location of release recorded. Sex was determined by the presence of spawning tubercles on the males during the spawning season. On mature fish, the males could be distinguished during all seasons by the presence of tubercle scars left from previous spawning periods. Fish which died during capture were dissected to determine condition of gonads and food habits.

#### *Tagging Fish*

River redhorse were tagged with a number FT-6A Floy fish tag (Fig. 2). This tag consisted of a double barbed nylon dart on a 1-in. nylon shaft and a 3.5-in. vinyl tube. The tag number and return address were printed on the vinyl tube. The tags were inserted beside the mid portion of the dorsal fin in the second or third scale row down from the fin. Two scales were removed and the tag was inserted past the barb point into the posterior scale pocket by using the stainless steel applicator. The applicator was then removed and the tag forced deeper with the forefinger and thumb.



## RESULTS AND DISCUSSION

*Spawning Notes*

During the spring of 1966 river redhorse reportedly began shoaling on April 17. Spawning activities were confirmed by the authors on April 21, at which time the water temperature was 71 F. Heavy rains set in on April 22, and because of high, muddy water, no spawning observations were made. The water remained high and muddy until May 7 at which time the redhorse were off the shoals. Because of the high water during this period, many of the shoals on which redhorse had been observed earlier had been completely washed away. Unsuccessful attempts were made throughout the spring and summer of 1966 to capture young-of-the-year river redhorse by seining and with electricity. It is hypothesized by the authors that severe decimation of the incubating eggs occurred during the spring of 1966 as a result of the flooding river conditions. Similar decimation has been reported under flooding conditions to the eggs of other redd utilizing fish species (1, 4).

During the spring of 1967, river redhorse were first observed shoaling on April 10. The fish remained on the shoals until April 17. The water temperature during this period ranged from 72 F. on April 10 to 76 F. on April 17. Because of an unseasonal drought, the Cahaba River remained low and clear throughout the entire redhorse spawning period. The low, clear water facilitated observations of the entire spawning process. A seven-foot step-ladder was set in the middle of the shoals giving the observer a good vantage point. During the height of spawning activities redhorse were observed spawning only inches from the ladder.

River redhorse in the Cahaba River spawn on gravel shoals. The males precede the females onto the shoals. They were found to have free running milt 10 days prior to the females reaching spawning readiness. The redds were excavated by using the caudal fin in a sweeping motion, the mouth in a sucking motion, and the head in a pushing motion. Redds were observed in water from 6 in. to 3.5 ft. deep. The size of the redds varied from 4 to 8 ft across and were excavated to a depth of 8 to 12 in. into the gravel. Frequently there were overlaps from one redd to another. A minimum of eight redds were found on all spawning sites. After the redds were constructed the male took a position on the redd facing upstream. This practically motionless position was maintained until a female neared the redd. At this point the male darted back and forth across the redd in somewhat of a nuptial dance. In all spawning instances observed a second male came onto the redd, and in perfect harmonic motions, joined the first male in the nuptial dance. After the two males remained for a few seconds in this rhythmic movement the female took a position between the two males. The two males then pressed tightly against the female and all three began a series of tetanic vibrations. During these vibrations the eggs were released, fertilized and buried in the gravel. On several occasions one of the males left the formation after the tetanic vibrations had started, leaving one male and one female in the spawning act. In no instances did a female come onto a redd to spawn when only one male was present.

*Egg Development and Fecundity*

Egg development in the river redhorse was not evident on September 31, 1966. Early egg development was observed on January 7, 1967. Since no



sampling was conducted during the intervening period it was surmised that egg development began during the latter part of this period. During January, 1967, volumetric determinations indicated 220 eggs per ml. On March 20, 1967, the eggs had advanced to 121 eggs per ml and on March 31 were further advanced to 54 eggs per ml. Since spawning occurred 10 days following the last determination, it is assumed that further development occurred.

Egg counts made on river redhorse ranging in size from 17.9 inches to 22.1 inches total length indicated a range from 6,078 to 23,085 eggs per individual, respectively. Determinations were accomplished by volumetrics with the actual counts coming from 10 percent aliquots. The average size of the fish on which egg counts were made was 20.6 in. total length and the average number of eggs from the sampled fish was 14,626.

### *Juvenile River Redhorse*

Despite intensive sampling efforts by seining, electro-fishing and trawling, no juvenile river redhorse were collected in the Cahaba River during the two-year study period. However, the collection of juvenile river redhorse has seldom been recorded anywhere. Although young river redhorse were collected as sac fry from redds, the next smallest specimen taken was a 12.3-in. fish weighing 0.68 lb. Large numbers of juvenile black redhorse, *M. duquesnei*, and blacktail redhorse, *M. poecilurum*, were taken during attempts to collect juvenile river redhorse. Juvenile golden redhorse were also collected.

Eggs of the river redhorse were relatively large, ranging from 3 to 4 mm in diameter. Consequently, newly hatched sac fry were relatively large and were characterized by a three-lobed yolk sac extending nearly the length of the thread-like body. Within a week after hatching the sac fry averaged in excess of 13 mm in length with the remaining yolk having lost its three-lobed appearance.

On April 11, 1967, eggs were stripped and fertilized from ripe river redhorse collected in the Cahaba River. It was noted that eggs and milt were free flowing (Fig. 3) only in fish which had lost the mucus covering. This



FIGURE 3. Taking eggs and milt from river redhorse.

greatly facilitated the selection and handling of ripe fish. The eggs were incubated in hatching jars at a water temperature of 72 F. Somites developed approximately 48 hr following fertilization. Movement was first observed approximately 72 hr after fertilization. Hatching began on April 14 and was completed on April 15. Active and continuous swimming was observed on April 21 and the fry were stocked into ponds previously cleared of fish.

Growth of these fry was rapid, but not as rapid as that experienced in natural water by two juvenile specimens collected in Alabama (Table 1).

TABLE 1. Juvenile river redhorse collected in Alabama. Total lengths expressed to nearest millimeter.

Location	Date	Total length	Number	Range	Reference
Pond reared	4/21/67	13	8	12-15	Authors' collection
Pond reared	5/15/67	25	14	22-26	Authors' collection
Pond reared	5/30/67	38	6	36-39	Authors' collection
Pond reared	7/26/67	94	14	90-97	Authors' collection
Pond reared	8/ 9/67	104	26	97-112	Authors' collection
North River, Ala	7/21/66	107	1	—	Authors' collection
Cahaba River, Ala.	7/15/54	161	1	—	Auburn University 790

Rapid growth coupled with possible occupation of habitat not normally sampled may possibly account for the apparent scarcity of juvenile river redhorse. Observation of specimens reared in 15 gal. aquaria revealed that young river redhorse were extremely wary and skittish, even with daily feeding. This perhaps in part also explains the difficulty in capturing juveniles.

Dissection of pond-reared specimens revealed that the diagnostic character of reduced numbers of thickened pharyngeal teeth is valid for specimens as small as 22 mm total length. However, thickening of the teeth is more obvious in specimens of 36 mm total length and larger.

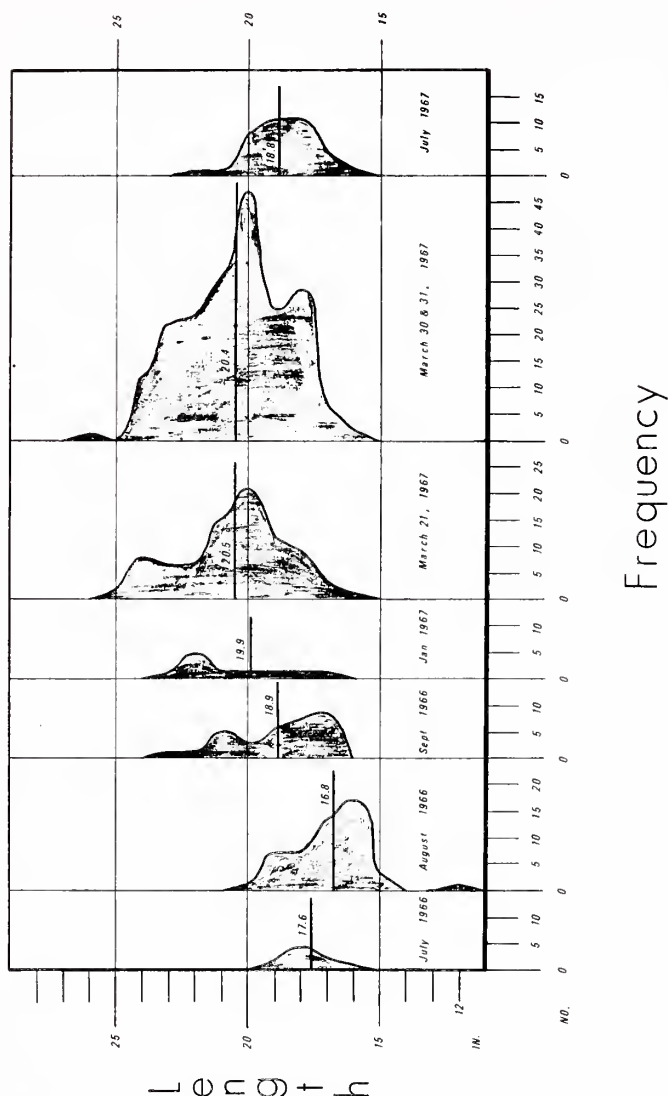
#### *Food Preference*

Stomach analyses during March, 1967 indicated that the river redhorse fed largely on bivalve mollusks. The primary bivalve mollusk consumed was the asiatic clam, *Corbicula* spp. Small particles of shell from the asiatic clam were predominant in all river redhorse on which stomach analyses were conducted. Other food items that were present, but in insignificant quantities, included larval Ephemeroptera, Chironominae, and Trichoptera. It is felt that the strong molar-like pharyngeal teeth found in the river redhorse facilitates the utilization of bivalve mollusk as a food item.

#### *Movement*

Seasonal sampling revealed a resident population of river redhorse in the Cahaba River. As evidenced by Figure 4, a buildup of large river redhorse occurred during March; however, the source of this buildup is uncertain. Possibly a number of redhorse ascend the Cahaba River from the Alabama River. It is equally plausible that the buildup is simply a concentration of the resident redhorse population. Because the sampled area was small and the sampling tool was ineffective in deep pools, it is quite possible that sampling during periods other than March excluded the larger redhorse.

In an attempt to further evaluate movement of river redhorse, 286 adults



were collected, tagged and returned to the Cahaba River during 1967. To date only four tagged fish have been recaptured. Three were captured with electric shocking equipment and one by hook and line. All four were recaptured while on shoals during the 1967 spawning season. One fish exhibited no movement over a 12-day period while during the same period one moved 15 miles upstream. The other two recaptured had each moved 10 miles upstream during a 22-day period.

## SPORT FISH POTENTIAL

*Non-game Sport Fish*

The definition of a sport fish is any fish taken by anglers for recreational purposes. It is interesting to note that the designation of non-game fish into categories such as rough fish, trash fish, or coarse fish, is the result of inability to utilize these species in a sporting capacity. Such classifications do not necessarily denote an inferior fish.

*Cahaba River Redhorse Fishery*

At present the Cahaba River affords a sport fishery for the river redhorse. The major portion of the annual yield is taken during the spawning season although a few are taken during other periods, usually incidentally, by bait fishermen. A small number of anglers bait areas to concentrate this species.

The principal methods used by sport fishermen to catch shoaling redhorse are: snaring (Fig. 5), whereby a wire loop attached to a stout pole is passed over the fish's head and drawn tight, and snagging with unbaited treble hooks. There is also some interest in gigging and bow fishing, both of which are legal methods for taking non-game fish in Alabama.

The large size and visibility of the fish during the spawning activities undoubtedly explain much of this species' appeal to redhorse fishermen. Interestingly, fishermen note the sexual dimorphism evident at this time and refer to the males as "horses" and the females as "mares". The flesh is palatable although bony and is often "scored" before cooking.

Present fishing pressure for river redhorse in the Cahaba River is light. Observation indicates that most of the shoaling populations are not visited by fishermen due to inaccessibility.



FIGURE 5. Snaring shoaling river redhorse in the Cahaba River



*Management as a Sport Fish*

The present policy is one of non-restricted utilization of this redhorse as a sport fish. The possibility of overfishing by anglers appears rather remote at this time. However, the high degree of vulnerability during the spawning activities would seem to indicate that this possibility cannot be entirely disregarded. It is felt that a much heavier rate of exploitation will be possible before there is a need to consider restricting fishing during the shoaling period.

As a species of fish becomes of interest to anglers, a need for sound management of the fishery is often seen. This is particularly true in the case of species which have suffered severe reduction due to habitat alteration, over-exploitation, or other causes. In addition to the life history study, the authors have attempted to obtain greater utilization of river redhorse by sport fishermen through the publication of a popular article (2) and public educational media.

Attempts to sell the public on the utilization of lightly sought non-game fish through public educational media are well taken. However, when a demand is developed for fishes formerly thought of in this respect, the biologist must be prepared to take whatever actions are necessary to preserve the fishery thus created.

## LITERATURE CITED

1. Allen, K. Radway. 1951. The Horokiwi Stream: A Study of a Trout Population. New Zealand Marine Dept. Fisheries Bull. No. 10.
2. Hackney, Peter A. and Walter M. Tatum. 1966. 'Redhorse are Shoaling' Cry Calls Fishermen to Cahaba. Alabama Conservation. October - November: 21 - 24.
3. Harlan, James R., and Everett B. Speaker. 1951. Iowa Fish and Fishing. State of Iowa: 66.
4. Hatch, Richard W. 1957. Spawning Habits of the Finger Lakes Rainbows. New York State Conservationist. Feb. - March. Vol. 11: 20.
5. Hubbs, Carl L., and Karl F. Lagler. 1957. Fishes of the Great Lakes Region. Cranbrook Inst. of Sci., Bull. 26: 65 - 66.
6. Reighard, Jacob. 1920. Breeding Behavior of Suckers and Minnows. Biological Bull. Vol. 38, January: 19 - 20.
7. Trautman, Milton B. 1957. The Fisheries of Ohio. Ohio State University Press.

## Experiments With Ferrocene

Samuel P. McManus  
Department of Chemistry  
University of Alabama in Huntsville  
Huntsville, Alabama

In view of the enormosity of the chemical literature annually, one of the chemical educator's most complex problems is the placement of modern trends in perspective. When an improved technique is devised, it may become necessary to delete the old methods from lecture material in favor of the new. When new areas of research become significant, however, one must make a judgement on how to include it without leaving out other important material.

One area currently needing greater classroom emphasis is the rapidly expanding field of organometallic chemistry. Although this is not a totally new area, it has become a significant one only in recent years. The wide range of properties that compounds in this class show makes organometallic chemistry not easily amenable to the standard text format. For this reason the chemistry of these compounds generally appears in more than one chapter.<sup>1</sup>

The examination of a dozen standard elementary organic laboratory manuals revealed that, consistently, only Grignard reactions represent organometallic chemistry. A search of the group of laboratory manuals for the use of non-benzenoid aromatic compound to demonstrate aromatic properties revealed only one case. Certainly these overlapping areas deserve more than the attention that they have been getting.

It is our contention that the experimental chemistry of aromatic compounds should include as many different types as is feasible. Thus, we have devised a series of experiments to allow the student to become acquainted with a non-benzenoid aromatic compound and with one of the more novel organometallic compounds. At the same time the student is introduced to column chromatography and metal hydride reduction of a carbonyl compound.

Using a modification of Bozak's procedure (3), acetylferrocene (II) is prepared (6) and separated from excess ferrocene (I) by column chromatography using petroleum ether as the eluant. Ether is then added to elute the acetylferrocene<sup>2</sup>. After removal of the ether and dissolution of the acetylferrocene in methanol, potassium borohydride is added to effect reduction of the ketone to the secondary alcohol after only a short reaction time. Recovery of the  $\alpha$ -hydroxyethyl ferrocene (III) by precipitation with water completes the sequence.

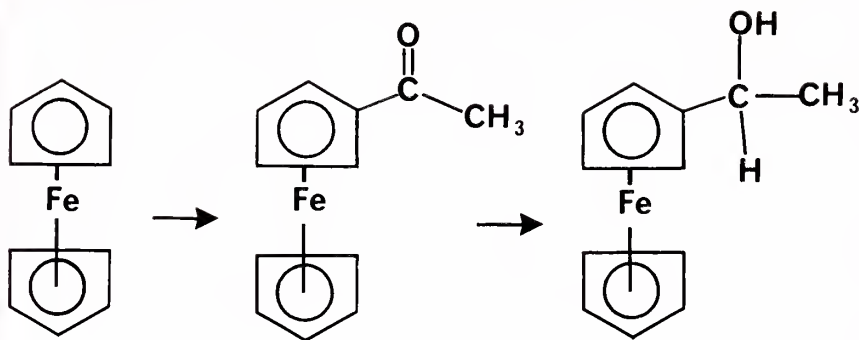
With the exception of drying the final product, the entire sequence can be completed in a 3 hour laboratory period. It is generally the case, however, for the average student to complete the chromatography and not have time to proceed. The reduction reaction is such a simple reaction to do that it can easily be programmed concurrently with the next scheduled experiment.

Yields of I were about 60 percent (5,6). Generally greater than 80 percent

<sup>1</sup> For example, Roberts and Caserio's, "Basic Principles of Organic Chemistry" (8) contains a chapter entitled Organometallic Compounds, yet transition metal complexes are covered in the chapter on Arnes.

<sup>2</sup> Professor Bozak's procedure (3) recommends benzene or petroleum ether-ether. We have determined benzene to be too slow, and find ether to be satisfactory alone. Ether also is easiest to remove.





yields of III were obtained. Melting points of both were acceptable with respect to published values.

The colors of the compounds (I, orange; II, red; III, yellow) and their crystalline character make them easy for the student to work with and identify. We believe this series of experiments goes a long way in introducing non-benzenoid systems and unique transition metal complexes.

## EXPERIMENT

### *Preparation Of Acetylferrocene*

Three g ferrocene and 10 ml acetic anhydride are added to a 50 ml round bottom flask. Two ml of 85 percent phosphoric acid are added carefully while swirling the contents in the flask. The flask is fitted with an air condenser and a calcium chloride tube, heated with swirling (charring occurs if the flask is allowed to stand undisturbed) on a steam bath for about 10 min, and the contents are poured in a 400 ml beaker containing about 40g ice chips. After the ice is melted, 200 ml saturated sodium bicarbonate solution are slowly added with stirring. After allowing the solution to stand about 10 minutes, the brownish solid<sup>3</sup> is filtered using a suction funnel and washed with water. The solid should be air dried for about 15 min.

### *Chromatography Of The Crude Acetylferrocene*

Prepare a chromatography column by adding 60g of acid-washed alumina slowly to a column, a 100 ml buret or various tubes (4) will serve the purpose, containing petroleum ether. Top the column with a layer of sand. The crude acetylferrocene is dissolved in a minimum amount of benzene and introduced to the column. More benzene is used as required to rinse the flask and to wash down the walls of the column. After the liquid level just disappears into the sand, petroleum ether is added to elute the unreacted ferrocene. After the last of the yellow color (ferrocene) is eluted, ether (3) is added to elute the red-orange acetylferrocene. Evaporation of the solvents from each fraction yields the respective product. Acetylferrocene melts at 85-86 C (5); ferrocene melts at 173-174 C (7).

<sup>3</sup> Determined by gas chromatography (2) or by weighing the individual chromatography fractions to be 58-68 percent acetylferrocene.

*Reduction Of Acetylferrocene*

A 1.50g sample of acetylferrocene in 40 ml dry methanol in a 125 ml Erlenmeyer flask is treated with 0.6 g powdered potassium borohydride. Mix the contents by occasional swirling over a period of 15 min. Filter away unreacted potassium borohydride and catch the filtrate in a 250 ml Erlenmeyer flask. Dilution of the solution with 100 ml water precipitates the yellow alcohol. Cool the solution in ice water for a few minutes and collect  $\alpha$ -hydroxyethyl ferrocene on a suction funnel. After drying the product in a desiccator, record its weight and melting point;  $\alpha$ -Hydroxyethyl ferrocene melts at 76-77 C (1).

## ACKNOWLEDGEMENTS

This research was supported in part under a NASA Sustaining University Grant.

## LITERATURE CITED

1. Arimoto, F. S., and A. C. Haven. 1955. Derivatives of Dicyclopentadienyliron. J. Amer. Chem. Soc. 77:6295-6297.
2. Ayers, O. E., T. G. Smith, J. D. Burnett and B. W. Ponder. 1966. Gas-liquid Chromatography of Ferrocene Derivatives. Anal. Chem. 38: 1606-1607.
3. Bozak, R. E. 1966. Acetylation of Ferrocene. J. Chem. Ed. 43:73.
4. Fieser, L. F. 1964. Organic Experiments. D. C. Heath and Co., Boston.
5. Graham, P. J., R. V. Lindsey, G. W. Parshall, M. L. Peterson, and G. M. Whitman. 1957. Some Acyl Ferrocenes and Their Reactions. J. Amer. Chem. Soc. 79:3416-3420.
6. Herz, J. E. 1966. Optimizing Experimental Conditions. J. Chem. Ed. 43:599.
7. Kealy, T. J., and P. L. Pauson, 1951. A New Type of Organo-iron Compound. Nature 168:1039-1040.
8. Roberts, J. D., and M. C. Caserio. 1964. Basic Principles of Organic Chemistry. W. A. Benjamin, Inc., New York.
9. Robertson, G. R., and T. L. Jacobs. 1962. Laboratory Practice of Organic Chemistry, 4th ed. The Macmillan Co., New York.
10. Tanikawa, K., and K. Arakawa. 1965. Organometallic Compounds IV. Analytical Determination of Ferrocene Derivatives by Gas Chromatography. Chem. Pharm. Bull. (Tokyo) 13:926-931.

## Reactions Of Formamide With Fenton's Reagent And Hydrogen Chloride

R. C. Sheridan and W. D. Wilhide  
Tennessee Valley Authority  
Muscle Shoals, Alabama

Formamide,  $\text{HCONH}_2$ , is readily prepared by the catalytic reaction of carbon monoxide and ammonia, and is an intermediate in the synthesis of other chemicals. It contains 31.10 percent nitrogen and is potentially useful in the preparation of new nitrogenous fertilizers. In a study of its chemical properties, formamide was converted to oxamide and formamide hemi-hydrochloride by two new reactions.

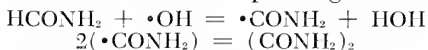
### OXIDATIVE DIMERIZATION OF FORMAMIDE TO OXAMIDE

The action of ferrous ions on hydrogen peroxide in aqueous acid solution produces free hydroxyl radicals.



This powerful oxidizing system was first investigated by Fenton (3) whose name is given to the reagent. Hydroxyl radicals generated by this method have been used in the oxidation of several organic compounds (4) and in the oxidative dimerization of certain ethers and esters (5).

We have found that formamide is converted to oxamide, an experimental slow-release nitrogen fertilizer, by Fenton's reagent. A hydroxyl radical apparently abstracts the hydrogen atom from the carbon atom of the formamide molecule, and the formamide radicals couple to give oxamide.



Neither of the isomers of oxamide, N-formyl urea or sym.-diformyl hydrazine, were detected in the reaction mixture. The absence of these isomers indicates that the attack of the hydroxyl radical is selective and abstracts hydrogen from only the carbon atom.

The yield of oxamide was 12 percent when the reaction was carried out at 0 C with equimolar amounts of ferrous sulfate, hydrogen peroxide, and formamide. As shown in Figure 1, the yield increased to 25 percent, based on hydrogen peroxide or ferrous sulfate, when the amount of formamide was increased to 8 moles per mole of hydrogen peroxide. Beyond this ratio of reactants, there was no further increase in the yield of oxamide.

The synthesis of oxamide by the Fenton reaction is neither practical nor economical for the production of fertilizer, but the reaction is of academic interest since no other reagent is known to bring about the oxidative dimerization of formamide.

### ADDITION OF HYDROGEN CHLORIDE TO FORMAMIDE

Several carboxylic acid amides, acetamide for one, form hydrochloride salts by simple addition of hydrogen chloride, but this reaction of formamide has not been reported. In 1910 Röhler (6) reported the preparation of a formamide hydrochloride with the composition of  $\text{HCONH}_2 \cdot 3\text{HCl}$  by passing gaseous hydrogen chloride into cooled, neat formamide. Schwab (7) showed

that Röhler's product was almost all ammonium chloride, and he, also, obtained only ammonium chloride from the reaction of formamide with hydrogen chloride. Schwab concluded that a formamide hydrochloride does not exist, but Bosshard and Zollinger (2) recently reported the synthesis of formamide hemi-hydrochloride by the reaction of phosgene with formamide.

We prepared formamide hemi-hydrochloride,  $(\text{HCONH}_2)_2 \cdot \text{HCl}$ , quantitatively by passing anhydrous hydrogen chloride into a cold chloroform-dioxane solution of formamide.



The white, crystalline compound is very hygroscopic and corrosive, but is stable at room temperature in sealed containers. Formamide hemi-hydrochloride melts at 56-57 C and is neutralized by gaseous ammonia to form formamide and ammonium chloride. The compound is insoluble in common organic solvents, and decomposes in contact with water.

These results confirm the existence of a formamide hydrochloride and show that formamide behaves similarly to other organic amides in combining directly with hydrogen chloride.

## EXPERIMENTAL

### *Preparation of $(\text{CONH}_2)_2$*

To a vigorously stirred solution of 0.1 to 1.4 moles of formamide and 0.1 mole of  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  in 100 ml of 2 N  $\text{H}_2\text{SO}_4$  at 0 C was added dropwise a solution of 0.1 mole of  $\text{H}_2\text{O}_2$  (30%) in 50 ml of 2 N  $\text{H}_2\text{SO}_4$ . The addition

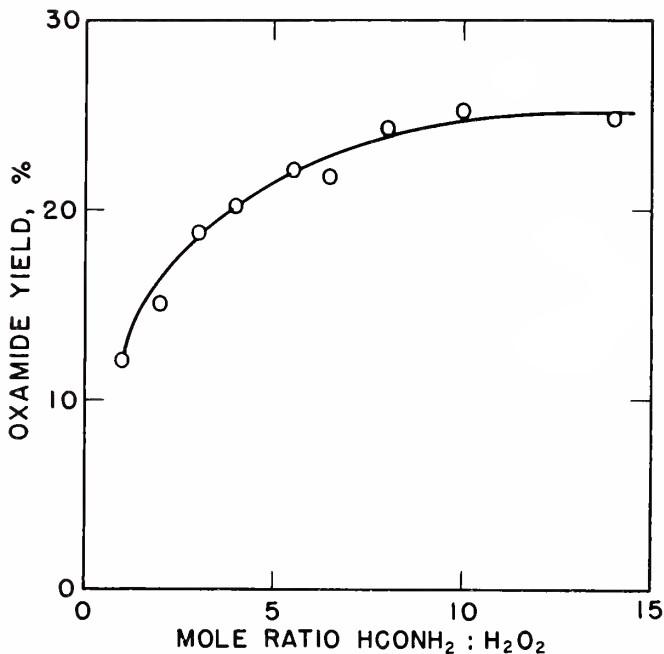


FIGURE 1. Conversion of Formamide to Oxamide by Reaction with Hydrogen Peroxide.

was made over a period of 20 to 40 min, and the mixture was stirred for an additional 15 min and then filtered. The crystals of oxamide were homogeneous, large, and well formed (1).

Lower yields were obtained with shorter reaction times, at higher temperature, or with simultaneous addition of solutions of ferrous sulfate and hydrogen peroxide to solutions of formamide in acid. Addition of 0.1 mole of  $\text{H}_2\text{O}_2$  to a filtrate from a typical run increased the yield of oxamide, based on a ferrous sulfate, from 25 to 34 percent. Most of the reaction mixtures contained a little hydrogen cyanide.

#### *Preparation of $(\text{HCONH}_2)_2 \cdot \text{HCl}$*

Anhydrous hydrogen chloride was passed for about 35 min at 0 C into a solution of 4.53 g (0.10 mole) of formamide (reagent grade, purified by two vacuum distillations) in 15 ml of chloroform and 15 ml of dioxane. The precipitate was filtered off, washed with ether, and dried under nitrogen to yield 6.25 g (0.05 mole, 99%). Titration with standard base gave an equivalent weight of 125.6 (calcd. 126.5). *Anal.* Calcd. for  $\text{C}_2\text{H}_7\text{O}_2\text{N}_2\text{Cl}$ : N, 22.14; Cl, 28.02. Found: N, 21.6; Cl, 28.2.

#### LITERATURE CITED

1. Ayerst, E. M., and J. R. C. Duke. 1954. Refinement of the Crystal Structure of Oxamide. *Acta Cryst.* 7: 588.
2. Bosshard, H. H., and H. Zollinger. 1959. Die Synthese von Aldehyden und Ketonen mit Amidchloriden und Vilmeier-Reagenien. *Helv. Chim. Acta* 42:1659.
3. Fenton, J. H. 1894. Oxidation of Tartaric Acid in Presence of Iron. *J. Chem. Soc.* 65: 899.
4. Merz, J. H., and W. A. Waters. 1949. Some Oxidations Involving the Free Hydroxyl Radical. *J. Chem. Soc.* 5-15.
5. Razuvaev, G. A., and L. S. Boguslavskaya. 1960. Syntheses by Means of Free Hydroxyl Radicals. 1. Oxidative Dimerization of Aliphatic Ethers and Esters. *J. Gen. Chem. USSR* 30: 4094.
6. Röhler, H. 1910. Untersuchungen über Formamide als Lösungsmittel für Anorganische Salze und über die Elektrolyse dieser Lösungen. *Z. Elektrochem.* 16: 419.
7. Schwab, G. M. 1950. Formamide Hydrochloride. *J. Electrochem. Soc.* 97:220C.

## The Montgomery Papers

Sandor Szilassy  
Indiana State University  
Evansville, Indiana

John Fluornoy Montgomery was a faithful member of the Democratic party and did not offer any resistance when the New Deal lifted him out of the presidency of the International Milk Company and put him in the dignified but poorly paid position of Minister to Hungary in June, 1933. At that time he was as ignorant about Hungary as most Europeans are about Alabama or Indiana. Before leaving the United States, he heard at the State Department that while Hungary was a puppet of Italy and had no independence of action, she was of importance as a listening post.

In July, 1933 the new Minister interrupted his journey in London, where he met with Secretary of State Cordell Hull. Some days later he and his wife arrived in Budapest and moved to the apartment of Nicholas Roosevelt, who was Montgomery's predecessor. Some weeks later they found a larger and better home, which was remodeled at the cost of \$17,000. Naturally, all the expenses were paid by Mr. Montgomery. It is quite well known that in the 1930's the miserable salary of American diplomats was barely enough for maintenance, and they had to pay from their own pocket for gala dinners and entertainment which were part of the job. This was the reason that the President had to select rich, amateur politicians even for the most important diplomatic posts, whose duty was a generous contribution to the party cash box among others. In 1933 Ambassador Biddle gave \$100,000, Ambassador Morris \$50,000, Long \$75,000, and another wealthy diplomat sacrificed \$150,000 on the altar of the ruling party.

Montgomery had a nice, outgoing personality, and the members of the high society in Budapest quickly learned that he was a rich man and a generous host. Very soon he was on friendly terms with many aristocrats and leading politicians.

His memoranda, personal correspondence and diplomatic papers, which I received from his daughter, shed some light on life in Budapest during the depression years. Most of the prominent Hungarians lived quite well then in comparison to the living standard of the unemployed who were kept alive by free public soup kitchens, but some of the leading families had not seen meat for months either, according to Montgomery.

Archduke Hapsburg Joseph and his wife, Augusta, the daughter of Emperor Francis Joseph, were invited by Montgomery at least once a year. This belonged to diplomatic protocol because Joseph was the second in rank in Hungary, although did not have any kind of political power. They demanded the right of checking the guest list in advance before each legation dinner. Joseph was well known as the friend of roses and gypsies; he even learned the Gypsy language. Augusta smoked long cigars after each meal. They were dignified and boring. Ramsey, the British Minister told Montgomery once after a party that he had to attend in the palace of the Archduke:

"I arrived as a royalist, left with anti-royalist convictions and after another party I will be a communist . . ."

Montgomery had excellent relations with Regent Horthy, whom he liked and respected. In one of his memoranda I found this story: During a per-



formance at the Opera in 1939 Montgomery heard Nazi chanting and anti-government shouting and saw that the Regent disappeared from his seat. He went to investigate with his son-in-law and found Horthy in a lobby, where he was slapping the face of several pro-German youngsters, repeating: "So you would betray your country, would you?" Horthy was alone, his guards did not know where he went.

Most of the Prime Ministers, Foreign Ministers and his colleagues were among Montgomery's friends, but his best friend was the leader of the opposition Small-holders' Party, Tibor Eckhardt. In Montgomery's opinion Eckhardt was an American type politician who he hoped would push through the secret ballot law and the democratization of public life in Hungary.

The shadow of Nazism was already on the horizon when Montgomery took over the American Legation in Budapest. Italy seemed to have a key position in the struggle for influence in Central Europe, mainly because Mussolini at that time supported Austrian independence. It was generally believed in Hungary too, that if Hitler were master of Vienna, the road to Constantinople and Eastern Europe would be thrown open. His goal was served by the fact that only small splinter-states were in his way, since the Hapsburg-ruled Austro-Hungarian monarchy fell apart in 1918.

As Montgomery writes, many Americans thought in the early 1930's that Hitlerism was the child of a conspiracy of German aristocrats and militarists, the so called "junkers", but it was rather mobocracy, or the German brand of Stalinism. Many of the junkers and the monarchists were the sworn enemies of Hitler. He and his associates considered the Hungarian social and political structure outdated and didn't like the hard-headed Regent, but otherwise showed some kind of friendship to Hungary until World War II broke out.

Hungary was surrounded by enemies in the north, east and south. Czechoslovakia, Rumania and Yugoslavia were members of the Little Entente system which was aimed at the permanent subjection of Austria and Hungary. In Czechoslovakia non-Czechs amounted to more than one half of the population and Benes was worried about the future of his country. Rumania and Yugoslavia also had sizeable national minorities, including about two million Hungarians, and this contributed to the ill feelings between Hungary and the so called successor states.

During his first three years in Budapest, from 1933 to 1936, Montgomery was convinced that Hungary had followed an independent path in the field of international relations, cleverly balancing between Italy and Germany. Then came the Italian-Ethiopian war and the League of Nations sanctions against Italy, which were initiated by Mr. Eden, who first represented England in the League and became British Foreign Minister in December 1935. The sanctions threw Italy into the arms of Nazi Germany. Earlier in 1934, when Mussolini, Dollfuss, the Prime Minister of Austria and Gömbös, the Hungarian Premier, signed a Three Power Pact which was supposed to defend and preserve the independence of Austria, things looked different. The balancing act of Hungary became more complicated two years later, when Italy seemed to lose interest in its northern neighbor. From 1937, after Italy left the League of Nations, Hungarian diplomats frequently were advised by Ciano that they should follow the German line.

Perhaps 1939 was the most exciting year for Montgomery during his entire work in Budapest. His diplomatic correspondence and memoranda re-

flect the feverish efforts of the Hungarian government to try to stay out of the war and not to be occupied by Germany.

After the Vienna award of November 3, 1939, which returned Hungarian-inhabited regions of Slovakia to Hungary, it seemed that the foreign policy of the Budapest government came under the increasing influence of Germany. The recognition of the Japanese puppet state of Manchuria in January, 1939, showed that Hungary had undertaken certain obligations in return for a reluctant German support of Hungarian irredentist aspirations. In addition to this, Hungary joined the anti-Comintern pact in February, in spite of the warnings of many conservative Hungarian politicians who considered it as siding with the German system of alliance and the tying of Hungarian policies to Hitler's war machine.

On March 15, 1939, German troops occupied Bohemia and established a Slovak satellite state. Previously, on March 14, before the expiration of the German ultimatum to Prague, Hungarian troops entered Carpatho-Ruthenia and on the 16th reached the Polish border in the midst of the jubilation of Poles and Magyars. The Hungarian government learned from Berlin that the German forces wanted to occupy the entire Czechoslovakia which would have resulted in the complete outflanking of Hungary from the north; therefore, they took the first step.

On March 17, Prime Minister Count Pál Teleki stated in a speech that the armed action was made possible by the friendship between Hungary and the Axis powers, but it was evident that it was in contrast to German interests. The Hungarian Deputy Foreign Minister, János Vornle, declared before Montgomery that "Hungary had no agreement whatever with Germany as to united action." He also emphasized that "Hungary's position vis-a-vis Germany is such that nobody can afford to lose an opportunity to pay compliments." The most influential Hungarian diplomat, retired Foreign Minister Kálmán Kánya, added to this that even Hitler's Foreign Office never knew what his plans were. Of course, it was generally known that Hitler was ready to attack Czechoslovakia, because earlier in March charges by the Czech Government that Slovakian Premier Tiso was intriguing to separate Slovakia from Czechoslovakia, led to a crisis and a convenient pretext for Hitler to act.

Orłowski, the Polish Minister "knew positively that the Hungarian Minister to Germany came in an aeroplane" to Budapest on March 12 and had given the German consent to Hungarian occupation of Ruthenia. He said that further incursion into Slovakia by Magyar troops was also approved on condition that Hungarian troops be placed on the Rumanian frontier. Thus Germany was able to frighten Rumania into a trade agreement at the expense of Hungary, which paid for the mobilization and the Germans got the trade treaty.

It turned out later that Orłowski was wrong. Hungary did not get additional territories because Hitler suddenly guaranteed the Slovak frontiers and the mobilization obviously was not directed against Rumania, which had a larger and considerably better equipped army than Hungary. Vornle evidently told the truth to Montgomery; the rest was political gossip.

The territorial and political changes that took place on the European continent also influenced Hungarian internal politics, which Montgomery was very much interested in. On January 6, Prime Minister Imrédy announced the establishment of his extreme rightist Hungarian Renaissance Movement, which was supposed to strengthen his political basis as well as to weaken

the Hungarian Nazis, whose propaganda demands were expropriated by the new party. In February it turned out that Imrédy, who pressed the anti-Jewish legislation, was himself partially of Jewish extraction. Then there was no way out and the Prime Minister who was clinging to power so strongly, had to resign. He was followed by Count Pál Teleki, who was three times Foreign Minister and once Prime Minister in the 1920's. He was also a popular Boy Scout leader, and a geographer of international reputation. Some weeks later Teleki submitted the secret ballot law to Parliament which was pending ever since Premier Gömbös promised it to Eckhardt in return for his support and included it in his program in 1932. Montgomery's May 12 conversation with Bethlen, who was Hungarian Premier from 1921 to 1931, illuminated the background of the election campaign. Bethlen thought that the Smallholders Party of Eckhardt would have more supporters in Parliament after the elections, "certainly not less," and said Teleki told him that Imrédy presented a list of 60 candidates but Teleki accepted only 12. Bethlen explained that a strong parliamentary opposition was not against the wishes of Teleki because this enabled him to resist German demands. The Prime Minister expected the Nazis to get 40 seats, and possibly less.

The elections proved that the German money was not spent in vain. Although the government party retained its majority, 56 Nazi deputies were elected, who marched into the first session of Parliament in uniform with fascist salute.

After the annexation of Czechoslovakia the impotency of the French and British governments was almost proverbial, but it turned out that small countries in Europe could not expect help from the other side of the ocean either. Foreign Minister Count Csáky in March confidentially informed Eckhardt about a letter of János Pelényi, the Hungarian Minister to Washington, in which he reported about a conversation which took place between him and Undersecretary of State Sumner Welles. According to Pelényi, the Secretary told him that "Germany would dominate Europe for the next five years." This was in connection with Eckhardt's saying to Csáky that "Germany's domination wouldn't last over a year and Hungary should be careful." Csáky used Welles' supposed statement to defend Hungary leaning toward Germany since they could not do anything else. In April, the world press reported that the request of Bata, the Czech shoe manufacturer, for a visa was refused by American authorities, with the reasoning that his passport was made out by the government of a non-existing country. This decision underlined Welles' views about an irresistible German advance on the European continent and proved that America, too, openly acquiesced in the Nazi annexation of Czechoslovakia. The waves of aggression ran over Europe and many people believed that they had to swim with the stream.

In February the Hungarian Minister of the Interior courageously banned the Hungarian Nazi organizations, but they were reorganized immediately under new names. On April 18, upon the pressure of Berlin, the constitution of the German Bund in Hungary was approved by the government and on June 5, Frick, the German Minister of Internal Affairs, arrived in Hungary to examine the "complaints" of the German national minority. This was an ominous step, because the annexation of Czechoslovakia also started with German demands for complete autonomy to the Sudetenland.

In the meantime, the German expansionist policy extended its feelers toward Poland. Goebbels and his associates concocted new claims and border

violations at regular intervals. Earlier, some observers believed that Germany was bluffing and its only goal was to extort some minor territorial changes from the Poles. Orłowski, the Polish Minister made it clear during one of his visits to the American Legation that "the Poles would never permit the Germans to take Danzig, by ultimatum or by any other method, *except by compensation*." He told Montgomery that there was a possibility of compensating them and there might be some arrangement made, but such an arrangement would not be anything as the Germans shoved on the Czechs. The Poles would fight in such a case, according to him. Orłowski didn't go into details, but his government was probably considering the possibility of a corridor to the Baltic Sea through Lithuania or East Prussia.

During the summer the situation grew considerably worse and the Hungarian Prime Minister thought it proper to state in a letter on July 24 to Hitler that "Hungary, because of moral considerations, is not in a position to start military operations against Poland." In another letter, also dated July 24, he explained to the Chancellor that "in the case of a general conflict Hungary will align its policy with the policy of the Axis . . . on the other hand our compliance with this policy cannot violate our sovereignty under any circumstances and should not obstruct the accomplishment of our national aims." This was a clear statement and the Germans understood that they could not count on Hungarian support in a war against Poland. In August, Horthy underlined the independent political line of Hungary by presenting the Grand Cross of the Order of Hungary to the president of the American IBM Corporation, and on September 10, after the German-Polish war started, Horthy and Teleki point blankly refused a German request for permission to use a small section of Northern Hungary, which included part of a railroad between Slovakia and Poland, for transient troop transportation. According to the minutes of the September 10 session of the Council of Ministers, "it is a matter of Hungarian national honor not to participate in any kind of military action. If the request would be granted, the neutrality of the country would be violated."

This was a daring statement then. Even Sweden, which remained technically neutral in World War II, gave permission for the transit of German troops and war materials across Swedish territory from Norway to Finland. The admission of tens of thousands of Polish refugees to Hungary was also an anti-German step. The wife of the Regent herself accepted the chairmanship of the organization which aided the refugees, and most of them could later join the Allied forces through underground channels.

Of course, the signing of the Russian-German non-aggression pact on August 23, and the subsequent partitioning of Poland set new tasks for the Hungarian leaders. (It is interesting to remark here that in his *Mein Kampf* which was published in 1926, Hitler declared that a Russian-German alliance would result in a war with the West, and such a war would mean the end of Germany.)

After returning from vacation in September, Montgomery visited the Prime Minister and found he was willing to talk more or less openly about anything with him. Teleki was inclined to put the blame on the British and the French for not giving more assistance to the Poles, but he also thought that the Polish High Command was dreadful. Marshal Ridz-Smigly and those surrounding him were more clever in politics than in warfare. Later he told Montgomery that the Germans will attack Denmark, Holland, Belgium, or



Norway and Sweden because "they offered a way through the enemy, a better military base or better control of the sea." He said that Hungary had fortifications under construction at both the Soviet and the German borders.

He predicted that Germany would lose the war; asked for intervention when negotiations were going on for the sale of American interests in the Hungarian Ganz Manufacturing Co. to the Germans; wanted to buy American planes for the Hungarian Air Force instead of German airplanes; and took every opportunity to meet with the American Minister. Montgomery was frequently invited to tea by the wife of the Prime Minister, but he always found the Prime Minister in the living room alone, without his wife.

At one such occasion in November, O'Malley, the British Minister, got the impression too that there was a growing conviction on the part of Hungary that the war was going against the Germans and it was better to be more friendly with the Allied Powers, and also America since that country might have much to say about the events of the future whether she entered the war or not. The Hungarians, in O'Malley's opinion, trusted the British and the Americans, but didn't like the French.

Late in 1939 Italian-German relations worsened. Count Malagola, an Italian diplomat who had just returned from Rome to Budapest, told Montgomery that "the latest move in the Italian cabinet took out German sympathizers, and since Ciano was known to be very anti-German he felt that the possibility of Italy going to war with Germany is out." He didn't see the Axis functioning, partly because of economic reasons. The Fiat factories were making motors for the French and those who were making woolens, manufactured them for the British army. Practically nothing went to Germany, since she had no money to pay for purchases.

Montgomery heard a story from Mrs. Ullein-Reviczky, the wife of the press section chief in the Foreign Ministry about the same topic. Italian newspapermen were unwilling to sit with their German colleagues at a party at the Carlton Hotel and di Vinci, the Italian Ambassador, went into a back room and waited there until von Erdmannsdorf, the German Ambassador, left. The Italians were especially upset about the Russian-German pact at that time, believing that the European power balance has shifted to the East, and Germany's foreign policy changed.

Kánya, the experienced Hungarian diplomat, did not see anything in the German-Soviet pact but the recognition that pan-Slavism and pan-Germanism could well work hand-in-hand to mutual advantage and play havoc with that portion of the world, including Italy. His impression was that neither Hitler nor Stalin ever kept their word, and therefore he didn't believe their understanding was close.

The French Embassy in Belgrade spread the rumor through a Hungarian diplomat in November that the Allies were planning the outflanking of the German Siegfried Line from the southeast, and that the plan was based on the Weygand army which was stationed in the Middle East. Of course, the main object of the rumors was the intimidation of small East-Central European bumper states which would have fallen in the way of the campaign. It is possible that this had contributed to the efforts of the Hungarian government for better relations with Yugoslavia at that time. The semi-official trip of Eckhardt to Belgrade in November was a significant step in that direction. The Serbs were interested in the Hungarian plan of an Adriatic bloc, consisting of Italy, Greece, Albania, Yugoslavia and Hungary, but the Croatian

Vice-Premier suggested to Eckhardt the resurrection of the Austro-Hungarian Empire instead.

Hungary's orientation toward America was emphasized by several meetings between the Regent and Montgomery in Fall, 1939. On November 15, Horthy made the following statement in the presence of the American Minister:

1. No small country in Europe is free from invasion, but Hungary has no such fears in the near future. Germany can get more from Hungary as a neutral.
2. No request was ever made for permission for German troops to cross Hungary to attack Rumania.
3. Horthy thought that American public opinion was keeping the Germans from going through Holland and Belgium.
4. He had reason to believe Germany and Russia had agreed to maintain peace in Southeastern Europe, so Germany could get supplies from here.
5. Axis still exists, but a German attack on Hungary would be tantamount to an attack on Italy. Hungary would resist with force any attempt to send troops through Hungarian territory.

Horthy also told him that he wanted to kick Nazi sympathizers out of the Cabinet and suppress the Nazi party. He got rid of one of them, the Minister of Commerce, who was forced to resign.

Horthy said among others, that there was a universal hatred in Central Europe because of centuries of warfare. "If God appeared to the King of Rumania and told him that unless he gave Transylvania back to Hungary, Rumania would be wiped out, there would be nothing the King could do because if he tried to do it, he would be put off the throne within twenty-four hours." The Hungarian policy, according to Horthy, was to stay alive between two millstones, and it was not a small task for a small nation.

Montgomery realized that the Hungarian government was more courageous and more successful than the governments of neighboring small countries, but this was only a temporary phenomenon. Hungary was not occupied by the Germans until March 1944, but the forced concessions that were gradually made for extremist groups and the increasing clamping of the German screw finally destroyed the dream of a Hungarian Switzerland.



## Notional Frontiers Of Environment

Earl P. Clere

Department of Geography  
University of Alabama, University

One of the more extra-ordinary features of geographers is their ability to sway. We are like the palm, nimble enough to sway, yet if the squall is of insurmountable force the arc in one direction will become a permanent bend. With dedication to mother nature the tree will once again strive to reach its zenith and claw through the pollution on a journey to the sun.

The wind which causes geographers to sway, arc, and eventually bend is the founded and unfounded opinions of their teachers and trends. On occasion some will broach these opinions and trends and be on their way into the mystic. Thus we grow.

There is little need to restate the stand taken by most geographers during the past fifty years on how their forefathers fought the battles of environmentalism within the great war of determinism and seemingly won the battles and the war. Today we should recognize the environment as all encompassing and not allow our thought process to be bounded by only the obvious as in the days of the old environmentalists who generalized at length. It is not the intent here to develop conclusions, but simply to attract attention to the need for geographers to extend their thinking and to reevaluate the term environment.

It has been common acceptance to establish an influence generated by the physical environment on the activity of living forms. Perhaps even a determining effect on the lower forms of life — but certainly not man. However, in the origin of man it had a determining effect, for had the periods of aridity not entered the Pleistocene and taken the trees away from pre-*Homo sapiens*, then what became man would never have come down from his haven of a splendid aboreal habitat. Well, you say, even though this be true man was really not man until he learned to cultivate, to become sedentary and this was recently — within the past 20,000 years. Then man was able to alter, modify and control his environment for he no longer had to adjust but rather he adjusted. Alter and modify yes, but not control.

We should not establish a distinction between man and the environment, there is none. Man and all that makes up his complex activity is a major part of the environment. It is a fallacy to separate the two. We should recall that there is no separation of cause and effect in the natural world. The idea of man adapting to an environment for the express purpose of survival is well founded. But what is adaptation if not the molding of the complexities that effect the organism; and what does the molding if not the environment?

If the term environment is accepted as meaning only the physical, what then is the meaning of "neo-environmentalism"? It is a term directed at the geography masses which has the same meaning as environment to a scant few. Both terms, environment and neo-environment, must include:

(1) Natural phenomena apart from the immediate organism. To these man has only adapted and is the only land/atmospheric living mammal that has adapted one species to 180° of latitude. He uses these phenomena but does not control. To control means total submission to a power. Man may alter, change, or modify bits and pieces of the natural phenomena but in order

to control these modifications would not be responsible for other factors, often within the natural phenomena, to get out of order.

(2) Time, without which no element natural or humanly modified would evolve. Time has allowed the physical being to survive through endurance and experience. Man has spent a million plus years evolving from innate to intelligent actions. Today there is still evidence of behavior patterns based upon innate action.

(3) Physiology, through the arrangement of genes to develop hereditary immunities without synthetic control.

(4) Social adaptation to the group or become a variant.

(5) Cultural, in that tradition can nullify the genetic potentiality.

From witnessing man's use of nature, his ability to alter his environment may be more a detriment than an asset. With the potential altering of chromosomes via the structure of DNA man will have adapted his tool making ability from the pebble tool to the computer and thus in making himself a computer from his own genes. However, this does not imply that man's technological achievements have surpassed biological evolution because until we know what the results will be before messing about we are not in control.

Man is one of the few, if not the only, species of mammal that deliberately establishes an organization to destroy members of his species. Until man can control man he is not clear of environmentalism.

It is an accepted fact that geographers enter into other disciplines — or is it not really that these enter into geography? Ethology, or the modern study of animal behavior, is an area which binds as no other that of the natural and human approaches to geography. It is the area of basic study for the anthropogeographer, if there are any left; of the biogeographer, the zoogeographer and the political geographer. But precisely it stimulates the mind of the environmentalist. Much of the work to date in ethology has been done by naturalists. Is there any truer naturalist than a geographer? Of course to the quantifiers the naturalist seems rather far removed from the contemporary scene. Few, if any, of the zoogeographers reached into the behavior of animals. The paleogeographer was bypassing the ethological pattern of early man. But there is no need to condemn because there was no trend in ethology to which the geographer would be attracted, other than that of a naturalist.

The study of animal behavior has been undertaken through the most synthetic of conditions — for the animals, these being laboratory studies. In only a few cases have extended studies been made in the natural habitat of the species where the findings were often in direct opposition to those of the laboratory. Habitat studies have resulted in stimulating ideas on behavior.

Eventually both scholar and layman arrived at a theory that the occupation of territory was, in numerous species which included man, the governing factor. We view territory as that which the individual deems that it be. It is water, air or land of any dimension. It is a board, tree or empty can. It is your cave, aghal, tent, home, your country. In those species which can be termed territorialists the demand for territory is the principal motivation or drive within the species, and this falls as a challenge to the male of obtaining and keeping the territory.

If we apply that to acquire territory and to develop it is the main drive behind the behavior of man, does this not follow the evolutionary path of geography, namely man-land relationship?

# Did The New Economics Fail In 1967?

Keith Bryant, Jr.  
Southern Research Institute  
Birmingham, Alabama

## INTRODUCTION

The performance of the American economy in 1967 led many critics of national economic policy to conclude that the "New Economics" failed and should be abandoned. This paper will look briefly at the performance standards set for the national economy by the new economists and the economic policies recommended to achieve these standards. Next, there will be a brief examination of the actual performance of the economy in 1967 and the policies followed. Finally, the performance standards and policy recommendations of the new economics with the actual performance and policies followed in 1967 will be compared in an attempt to answer the question — Did the new economics fail in 1967?

## THE NEW ECONOMICS: PERFORMANCE STANDARDS AND RECOMMENDED POLICIES

In brief, the new economics is a belief that the economy can achieve non-inflationary full employment by deliberate manipulation of federal government fiscal policy. A clear understanding of the performance standards thus implied requires a closer look at the definition given to noninflationary full employment. The authority to be used throughout this paper is Alvin H. Hansen, a former Harvard economics professor who has been called the American Keynes and whose former students include such economic advisers to government as Paul Samuelson, James Tobin, and Kermit Gordon. The views expressed by Hansen are considered to be fairly representative of those of the new economists.

Inflation of 1 to 2 percent each year is expected and considered to be reasonable price stability, and reasonably full employment exists with an unemployment rate of 4 to 5 percent. An attempt to achieve complete price stability is likely to result in undesirably high unemployment and low growth rates. The purchasing power of saving is not eroded unless price increases exceed the interest rate earned on saving, and nothing is more damaging to saving than unemployment. No real or pure inflation exists until prices rise faster than output. In his writing, Hansen makes it perfectly clear that he will gladly accept price increases of 1 to 2 percent yearly if that is the cost of a satisfactory growth rate.

Achievement of the desired performance standards depends quite heavily upon proper implementation of fiscal policy. The following statement is believed to represent Hansen's concept of the nature of this tool of national economic policy:

Fiscal policy is the use of government expenditures, taxation, and debt management in such a way as to control the price level, the employment level, and the size, distribution, and composition of the nation's output. (1)

A closer look at Hansen's recommended fiscal policy reveals that he urges that the level of government spending be determined by a social priorities test so that we may move toward achievement of social balance. This requires

a shifting of resources away from the production of private goods to the production of public goods. Thus the future is to hold rising public spending until the point is reached when the marginal utility from a public expenditure dollar and the marginal utility from a private expenditure dollar are equal. Until that time, the social priorities test is to determine the level of public spending; and this test, according to Hansen, dictates substantial increases well into the future. Government expenditures, therefore, can no longer be used in a countercyclical manner; the only spending changes are to be increases.

Assigning the task of achieving social balance to increased public expenditures has the effect of shifting virtually the entire responsibility for stabilizing the economy to taxation. Variations in tax rates are to regulate the volume of private spending so that the total of private and public expenditures will be sufficient to attain and maintain noninflationary full employment.

The weakness of the above policy against cost-push, or wage-push, inflation was recognized; and Hansen and his followers have urged that wage increases not exceed the average gain in worker productivity.

Thus the essence of the fiscal policy advocated by the new economists is that government spending is to increase until social imbalances are eliminated, and taxes are to be used as the primary stabilization weapon. Tax rates should be raised to combat inflation and lowered to combat unemployment. As an additional weapon against inflation, wages should rise no faster than productivity.

### THE AMERICAN ECONOMY IN 1967

The performance of the American economy in 1967 is summarized in Table 1; and when compared with 1966, the year 1967 was an impressive one in many respects. Gross national product was 5.6 percent above 1966 levels, and disposable personal income rose 7.1 percent. Per-capita disposable income climbed 5.9 percent, and compensation to employees increased 7.8 percent. Average hourly earnings in manufacturing in 1967 were 4.0 percent above 1966 levels.

The picture is much less impressive when other measures are considered which reflect the impact of price level changes. The price deflator for gross national product increased 3.0 percent, thereby deflating a 5.6 percent rise in output to a more modest 2.6 percent. The consumer price index rose 2.8 percent, although there was only a minor increase in the wholesale price index. When the gain in per-capita disposable income is adjusted for price increases, the rise of 5.9 percent shrinks to 3.3 percent.

The unemployment rate in 1967 was 3.8 percent, the same as in 1966. The average workweek in manufacturing fell from 41.3 to 40.6 hours; and this fact, along with rising prices, was primarily responsible for the decline of 53 cents in average weekly earning in manufacturing, after adjustment for price level changes. The index of output per man hour in the private economy, an often-used measure of productivity changes, registered a relatively small gain of 1.7 percent.

The government sector grew much more rapidly than did the overall economy in 1967. Total government expenditures, including transfer payments, went up 14.4 percent. The most rapid growth, 19.8 percent, was in federal purchases of goods and services for national defense. Federal pur-

chases for non-defense purposes increased a relatively modest 5.4 percent, which was slightly less than the 5.6 percent growth in gross national product. State and local government purchases of goods and services displayed a 11.9 percent gain over the previous year.

Economic policy followed during 1967 was clearly expansionary as all major classes of government expenditures, except federal purchases of non-defense goods and services, increased at rates considerably in excess of the growth rate for gross national product. Also, there was no significant tax increase at the federal level.

### COMPARISON OF 1967 ECONOMICS WITH THE NEW ECONOMICS

Did the performance of the American economy in 1967 meet the new economics' standards of noninflationary full employment? An affirmative answer can be given in only one category — the unemployment rate of 3.8

TABLE 1. Selected measures of economic activity, 1966-1967

Measure	1966	1967	Percentage Increase
Gross National Product (billions of current dollars)	743.3	785.0	5.6
Gross National Product (billions of 1958 dollars)	652.6	669.3	2.6
Disposable Personal Income (billions of current dollars)	508.8	544.7	7.1
Compensation of Employees (billions of current dollars)	435.7	469.7	7.8
Per-capita Disposable Personal Income (current dollars)	2,584	2,736	5.9
Per-capita Disposable Personal Income (1958 dollars)	2,317	2,393	3.3
G.N.P. Price Deflator (1958 = 100)	113.9	117.3	3.0
Consumer Price Index (1957-59 = 100)	113.1	116.3	2.8
Wholesale Price Index (1957-59 = 100)	105.9	106.1	0.2
Unemployment Rate, per cent	3.8	3.8	—
Labor Participation Rate, per cent	60.1	60.6	0.8
Average weekly hours of work, manufacturing	41.3	40.6	(1.6)
Average hourly earnings, manu- facturing (current dollars)	2.72	2.83	4.0
Average weekly earnings, manu- facturing (1957-59 prices)	99.33	98.80	(0.5)
Industrial Production Index (1957-59 = 100)	156.3	157.8	1.0
Index of output per man hour, private economy (1957-59 = 100)	129.3	131.5	1.7
Government expenditures (billions of current dollars)	209.8	240.0	14.4
Government purchases of goods and services (billions of current dollars)	154.2	176.3	14.3
Federal, national defense	60.5	72.5	19.8
Federal, all other	16.5	17.4	5.4
State and local	77.2	86.4	11.9

Source: *Economic Indicators*, February, 1968.



percent does fall below the 4 to 5 percent considered acceptable. On the other hand, an inflation of approximately 3 percent clearly exceeds the 1 to 2 percent considered to be reasonable price stability. There was no "pure" inflation, however, with prices rising faster than output, but the standard for reasonable stability was definitely violated.

The appropriate new economics policy for 1967 would have been one designed to control inflation at reasonably full employment levels of output. The primary reliance would have been placed on higher taxes. President Johnson did recommend a 6 percent surcharge on individual and corporate income taxes (2), but the measure never left the House Ways and Means Committee. Also, considerable attention would have been given to ways of restraining wage increases in excess of productivity. Actually, there was little serious effort to attain a balance between wages and productivity. The index of output per man-hour in the private economy rose 1.7 percent in 1967; but average hourly earnings in manufacturing went up 4.0 percent, and the wage increases in such areas as construction and services were even higher.

The new economists recommend increases in government spending until the claimed social imbalance has been eliminated. The overall level of government expenditures did rise faster than gross national product, possibly in pursuance of such a goal. The burden of combatting inflation has been assigned to increases in taxation by the new economists, but Congress did not enact the recommended higher taxes.

#### DID THE NEW ECONOMICS FAIL IN 1967?

Based on performance standards of the new economics, the American economy in 1967 failed to control inflation within tolerable limits, and wage increases significantly exceeded gains in productivity. The standard of full employment, however, was exceeded.

On balance, this writer does not consider it correct to label the new economics as a failure in 1967, because there was clearly a failure to follow the policy recommended to combat inflation. Perhaps there may also be a failure to understand that the new economists expect government expenditures to rise until social imbalance is eliminated; and higher taxes, therefore, are expected to bear the major responsibility for controlling inflation.

Rather than claiming that the new economics failed in 1967, it would be more accurate to say that the patient suffered because he failed to read and follow the instructions on his medicine bottle.

#### LITERATURE CITED

1. Bryant, Keith Jr. 1967. Alvin H. Hansen's Contribution to Fiscal Policy. Ph.D. Dissertation. School of Commerce and Business Administration, University of Alabama.
2. Economic Report of the President. 1967. U.S. Government Printing Office, Washington, D.C.



# Retail Store Patronage Decisions Among College-Age Negroes

James C. Carroll  
University of Alabama, University  
Department of Economics

## INTRODUCTION AND GENERAL METHODS

The Negro segment of the American consumer market is known to differ from the Caucasian segment with respect to physiological, social, cultural, political, and economic factors. It has long been recognized that Negro buying behavior is different from the buying behavior of Caucasians — presumably as a result of these aforementioned differences.

Buying behavior is defined as consisting of purchase motivations, expenditure patterns, and patronage decisions. It can be shown that Negro buying behavior is distinctly different. It follows that characteristic differences exist in the effective demand in the Negro market segment. It behooves retail merchants who are interested in developing and implementing marketing strategies that will attract Negro patronage to try to perceive the characteristic differences among Negroes in the same manner that Negroes perceive them.

This paper focuses upon the influences of 6 selected retail store operating characteristics which have been reported in the marketing literature for a number of years as being the most powerful determinants of Negro patronage of retail stores. These characteristics are:

1. Retail price levels
2. Availability of nationally advertised brands
3. Availability of credit
4. Employment of Negro personnel
5. Local newspaper advertising
6. Local radio advertising

The influences of these operating characteristics upon Negro patronage decisions were investigated with respect to food stores, drug stores, clothing stores, and furniture and appliance stores. These categories were chosen because new, additional Negro income is reported to be spent for the varieties of merchandise offered by these kinds of stores.

The objectives of this research were:

1. To test the collective significance of the 6 selected retail store operating characteristics.
2. To test the individual significance of the 6 selected operating characteristics.
3. To rank order the 6 selected operating characteristics with respect to their powers to influence Negro patronage decisions.
4. To evaluate the retail marketing strategies which correspond to the retail store operating characteristics, with respect to the effectiveness of the strategies in attracting Negro patronage.

Using a rank order scaling method, attitudinal data were obtained from 40 Negro seniors and 40 Negro freshmen at Stillman College, Tuscaloosa, Alabama, in October and November, 1967.

After transformation of the ordinal data into standardized normal scores

TABLE 1. Summary rank orderings of the six selected retail store operating characteristics by Negro seniors and Negro freshmen for the four selected store types.

Store Type	Rank order of retail price	Rank order of local newspaper advertising	Rank order of local radio advertising	Rank order of availa- bility of nationally advertised brands	Rank order of availa- bility of credit	Rank order of employ- ment of Negro personnel
Food	1	5	6	3	4	2
Drug	1	5	6	2	4	3
Clothing	1	5	6	2	3	4
Furniture & Appliances	1	6	5	3	2	4

to meet the assumption of normality, an analysis of variance was made which indicated collective significance of the 6 operating characteristics at the 5 percent level, but no significant differences among the 4 categories of stores. An additional analysis of variance for differences between Negro seniors and Negro freshmen indicated no significant differences at the 5 percent level.

Duncan's multiple range test<sup>1</sup> was used to test for individual significance of the selected operating characteristics. All were found to be significant at the 5 percent level.

## RESULTS AND DISCUSSION

Among the more interesting findings of the research were the summary rank orders assigned to the operating characteristics by the 80 college-age Negroes for each of the 4 categories of retail stores. These summary rank orders were obtained by the simple expedient of summing the ranks.<sup>2</sup> The computations were made from 4 frequency distribution matrices, one for each category of store, in which the column headings were the 6 retail store operating characteristics and the row headings were the rank orders 1 through 6. The rank orders are shown in table 1.

The rank orderings of the retail store operating characteristics by Negro college students indicated that retail price levels were the most powerful factor influencing store patronage decisions among the group studied. This finding suggests that among the better educated Negroes price buying may be more prevalent than the marketing literature indicates. The literature by and large represents the Negro as being fundamentally a quality buyer, depending upon known brands to identify quality merchandise.

The ranking by Negro students of the availability of nationally advertised brands in a number 2 position for drug stores and clothing stores and in a number 3 position for food stores and furniture and appliance stores tends to confirm the widespread contention in the literature that the availability of known brands of merchandise is a very strong attraction of Negro patronage, although for the students studied it is clearly subordinate in power to retail price levels.

The ranking by Negro students of the employment of Negro personnel in

<sup>1</sup> Duncan, D. B. 1955. Multiple Range and Multiple F Tests. *Biometrics* 11: 1-42.

<sup>2</sup> Guilford, J. P. 1954. *Psychometric Methods*. McGraw Hill Book Co., Inc., New York.

a number 2 position for food stores, a number 3 position for drug stores, and a number 4 position for clothing stores and furniture and appliance stores indicates that the employment of Negro personnel is a more important determinant of store patronage than some merchants may realize, but it is not as important as some literature on the Negro market suggests. At the present time this factor seems to occupy a middle ground position among the 6 operating characteristics studied.

The ranking by Negro students of the availability of credit in a number 4 position for food stores suggests that the small, independently owned grocery store in the Negro community may not be as important as a supplier of food to Negroes as it once was. Such stores traditionally have offered credit and sold food products at higher prices than chain supermarkets. This suggests a trend away from a long standing Negro patronage pattern.

The relegation of the availability of credit to a rank order position of 3 for clothing stores by Negro students suggests that the traditionally high incidence of credit purchasing of clothing by Negroes may be diminishing.

These speculations concerning the implications of the rank order position of the availability of credit are consistent with trends toward increased buying power among Negro consumers, and with the assertions contained in the literature that credit purchasing of food and clothing by Negroes has prevailed in the past because of necessity.

The rank ordering of the availability of credit in a number 2 position for furniture and appliance stores could be interpreted as meaning that Negroes use credit when buying furniture and appliances out of necessity, just as do many Caucasians. The literature suggests this motivation in Negro buying practices, but it also suggests that Negroes may use credit for furniture and appliance purchasing for prestige purposes.

The fact that the Negro students whose attitudes were analyzed ranked local newspaper advertising in a number 5 position for food stores, drug stores, clothing stores, and in a number 6 position for furniture and appliance stores suggests that local newspaper advertising may not be nearly as important in determining store patronage as much of the marketing literature alleges. The low ranking of this operating characteristic could be a regional phenomenon, or it could be that, even though Negroes are avid readers of local newspapers, the retail store advertisements do not make as strong an impact on them as many writers believe.

The ranking of local radio advertising in a number 6 position for food stores, drug stores, clothing stores, and a number 5 position for furniture and appliance stores suggests that Negroes, at least in the Tuscaloosa market, are not very strongly impressed by radio advertising messages sponsored by retail stores, even though their exposure to this advertising medium may be much higher than that of the Caucasian population. This finding is sharply inconsistent with the position held by many writers on the Negro market.

## RECOMMENDATIONS

Recommendations are made to retail merchants tentatively in view of the limitations of inference which apply to the research design. In view of some apparent differences in the manner in which retail merchants perceive Negro differences and the influence of these differences upon Negro demand, and the manner in which Negroes perceive their differences and the

influence of these differences upon Negro demand, certain recommendations are made. These are in the form of an evaluation of the 6 selected retail store operating characteristics. Recommendations of this nature seem appropriate too in view of the undetermined nature of the relationship between Negro differences and the formulation of marketing strategies related to the six operating characteristics.

Retail price levels being the most powerful determinant of Negro patronage decisions, *price strategy* formulation should take precedence over other strategies whenever competition on the basis of price is feasible. Food, drugs, clothing, and furniture and appliances are consumer goods which manufacturers have been able to differentiate rather successfully by means of packaging, branding, labeling, and the use of trademarks. This situation gives the merchant some control over price and facilitates the development of price strategies aimed at the Negro market.

The availability of nationally advertised brands is clearly a very important determinant of Negro patronage decisions. Accordingly, the development and implementation of *product service strategies* which embody substantial assortments of nationally advertised brands are strongly recommended to retailers who are interested in selling to the Negro market.

The attitudes of the Negro students toward the employment of Negro personnel which assigned this factor to an approximate middle position among the 6 operating characteristics suggests the wisdom of retail *organization strategy* being altered so as to include Negroes in responsible and conspicuous positions of employment — especially in retail food stores.

The results suggest the possibility that *credit* is a less influential determinant of Negro patronage than it once was. Consequently, it is recommended that retail *service strategy* minimize the role of credit as an attraction of Negro patronage.

The findings suggest that local newspaper advertising and local radio advertising are the least powerful of the determinants of Negro patronage. Since many retailers still depend heavily upon these forms of *information strategy* to attract Negro, as well as Caucasian, patronage it would appear that a deemphasis of these phases of retail information strategy is overdue. Possibly more attention to sales promotion and personal selling as vehicles for communicating with the Negro market is indicated.

The foregoing recommendations assume that the flow of causation generally is from Negro differences to the development of retail marketing strategies. It should be noted that while this assumption rests on casual observations by interested observers on both sides of the market, it has not been empirically demonstrated by scientific research.

# Opportunities For Teaching Science Abroad And The Values Derived

Ann Lucas  
Wenonah State Junior College  
Birmingham, Alabama

## A STATISTICAL VIEW OF INTERNATIONAL EDUCATION

A contributor to the North American Review wrote in 1856: "Americans have a special call to travel. It is the peculiar privilege of their birth in the new world, that the old world is left them to visit." Taste for travel and receiving the wonders of the world through varying cultures were once an exclusive privilege of a few.

Through programs of international education during the past twenty years, nearly 109,000 persons have traveled and worked abroad. Eighteen universities have 40 or more of their own faculty abroad; 72 universities through AID alone participated in projects overseas; and 75 universities have, with the support of the Bureau of Educational and Cultural Affairs, exchange relationships with universities in other lands. The State Department now conducts exchange programs with some 130 countries and territories, and we have bi-national agreements in effect with some 48 countries. The Basis for the International Educational Program is fundamentally projected through a mutual-understanding-centered philosophy.

Government sponsored programs, which represent the bulwark of international education, are projected through numerous goals and methods which supposedly lead to the achievement of mutual understanding.

In order to foster mutual understanding, there exists the need for expanded and first-hand knowledge of other countries, and the establishment of closer relationships with them. Such subsidiary goals are thought to best be achieved through international scholarship; the exchange of persons, ideas, cultures and tastes, and through educational cooperation and assistance. However, the exact measurement of such abstract goals is impossible. The extent to which individuals contribute to mutual understanding cannot be measured by any prescribed scale. It becomes difficult, but nevertheless challenging, for even a teacher grantee who can easily identify with abstract measurements of teaching-learning processess, to find a "niche" among these difficult to concretely define, goals.

International educators working under the same general goals, but in more specified areas such as projects of AID or UNESCO, to help develop and modernize the educational systems of new nations, and to train nationals in technical capacities, often find the means toward the end more visible than does the teaching grantee.

## THE MILIEU OF THE SCIENCE TEACHER GRANTEE IN NEWLY DEVELOPING NATIONS

The development of newly developing nations is directly related to science and technology; to the training of mass numbers of technicians, technologists, and scientists; and is inextricably bound to the educational structure. It is apparent that the goals of a highly industrialized, technical society rest heav-



ily on the general education of the society, and the spreading of science literacy among all of the people in order to project the values of and appreciations for a modern industrial society. Thus, a revolutionary period in science teaching methods and science content has been widely recognized as necessary. It is in an educational environment of synchronous dynamic and static conditions: traditionalism in some quarters, contemporariness in others, and a combination of the two in still others, that the American international educator teaches science.

There exists a colossal shortage of science teachers; a scarcity of modern textbooks (one text for every ten children in some instances); inadequate school laboratories and apparatus; rigid examination systems; strict adherence to the syllabus; extensive note taking; total use of the lecture method of teaching; adherence to learning by rote memory; and in many countries, a high resistance to change. Laboratory-student-teacher centered activities are virtually nonexistent.

### SCIENCE AND NON-SCIENCE ACTIVITIES

The teacher grantee soon determines that any small contribution toward the broad goals will come as a result of their regular activities. That any personal development or personal satisfactions will be derived as a result of: (1) acceptance by the natives, (2) student-teacher rapport, and (3) teacher-teacher rapport.

It is possible to live and work in this new environment for a year or more and achieve little, if any, personal development with respect to the culture and immediate society. Some Americans do it!! By far, grantees who measure a successful tour in terms of personal development and satisfaction find that the achievements are wrought through interaction with the natives and the total environment at every opportunity. Grantees who are reluctant to change and who possess a low capacity for acceptance spend a miserable tour of duty. The Serenity Prayer is certainly applicable during an international teaching experience.

Science teachers can make definite contributions through: (1) improving, designing, and using inexpensive laboratory apparatus, (2) participating in seminars and workshops for teachers and students, and (3) utilizing the natural resources and basic materials of the environment in the classroom. With respect to teaching duties, this grantee chose a simple theme "Science Can Be Fun" for the academic year in order to demonstrate the teaching of science in an interesting manner, and in order to project the varied methods through which science can be taught and learned. The theme was projected through science games, puzzles in the school newspaper, skits (unheard of!!), and varied methods of evaluation.

Frequently, the international teacher may be requested to lecture and write articles on various phases of the science education program in the United States. Opportunities to travel within the host country and surrounding countries aid extensively in personal development.



# Helping Academic Failures To Succeed In Science

J. Edward Griffith and Hollis C. Fenn  
Central High School, and Florence State University  
Florence, Alabama

## INTRODUCTION

This paper is a synopsis of experimental efforts made by one school on one section of the school population to meet the needs of each individual. Grade progress studies revealed that the seventh and eighth grades seemed to be the bottle-neck for normal school progress, thus study and experimentation were concentrated at this level. The vast majority of those who were experiencing failure or near failure in one field of study were also experiencing the same failure or difficulty in all academic fields.

The 180 pupils of the eighth grade were divided into six sections. Pupils of five sections were divided by subject matter field efficiency according to their academic performance of previous years. Group 1 was retained as a heterogeneous control group. Group 2 was made up of highly gifted students. Group 3 and 4 were average students. Group 5 was a little below average. Group 6 was far below average as far as academic progress is concerned. This study was based on Groups 5 and 6 and 1 (control group).

Each child's psychological problems were different, however, each had many problems in common with others of his group. Some of the common problems were:

1. The average reading level of the group was 4.2 grade level. IQ ranged from 70 to 90 according to the California Standardized Tests.
2. Each child accepted himself as a failure, no matter how hard he tried to cover or disguise his failure.
3. Each child needed to succeed at something in order to improve his self image. To quote the typical child, "I have not learned much in school."

After the basic problems of the children were analyzed, the teachers involved established the goal of enabling members of these below average groups to become normal progressing pupils.

## PROCEDURE

In order to meet this goal, a new program was written. In addition to placing each child in a special reading group, the course of study for the state of Alabama, eighth grade, was used as a guide. The greatest change was in the teaching approach. Each pupil had a standard science textbook, but due to reading difficulty, its use was limited. Much of the textbook material had to be rewritten for about a fifth grade reading level.

Previous work with slower students and regular classes had indicated that these pupils seemed to be able to learn and retain more knowledge by working with their hands. In order to test this theory, an eighth grade laboratory was set up in an old barracks building. Much of the Elementary Science Study (ESS) lab work was used as basic program. The ESS lab work was extended to meet the eighth grade course of study. A more detailed lab write-up procedure was required in order to encourage the pupils to express themselves.

The unit on the human body will serve as an example of the technique

used in the program. The first step was an attempt to help the pupil to realize how marvelous the human body is. This was done by letting the pupils compare the human body to a man-made machine. Terms and new words for the next day were introduced at the end of each period. A list was put on the over-head projector and each word was recorded in the student's notebook. Each word was pronounced by the teacher and all pupils repeated the pronunciation several times in unison. Then each word was repeated to the lab partner to check pronunciation. For homework the pupils were required to find the meaning of the words; most of the terms could be found in the textbook glossary. This required considerable time which would have been a waste in a regular class, but was of much advantage to this group. This allowed the pupils to follow the class lecture more closely.

The class lecture, if you could call it that, was illustrated with the over-head projection of systems of the body. In addition, a torso model was displayed. Each system was listed and the job performed by each system was outlined. The digestive system was the first complete system studied. Each child was required to draw each organ of the digestive system and to label it. They were also required to write a brief explanation of what happened to the food in each organ. While some pupils were doing this, others went to the life-size torso model and studied the digestive system in detail. They removed the organs from the torso model, comparing their size, shape, appearance, and location. They had to feel as well as see in order to retain the information.

The pupils were now ready for the lab. Each lab team of two people was given a toad. They were told to remove the muscle tissue over the torso-area carefully and to study the digestive system by dissection. The pupils were not required to remove each organ and dissect it, but each group did; they wanted to study the contents under the microscope. They were allowed to do so and they made drawings of what they found.

A senior biology student was asked to help the pupils with their individual dissecting problems. This gave the teacher a chance to talk to each pupil about his work. This technique was used quite often in order to strengthen the child's ability to express himself. These discussions were very informal and the pupils seemed to look forward to them.

After each lab exercise an open class discussion was held and the pupils were given the opportunity to share their lab experience and ask questions. The leader's only function was to keep order and guide the sharing.

The same procedure was followed with each of the other systems of the body. The same toad was used in the study of the muscular system. The skeletal system lab work consisted of boiling a chicken, removing the meat, and reassembling the skeleton, all as outlined in ESS lab work. The nervous system was the last system studied. Over-head projections of the nervous system were used. The lab work consisted of ESS study of the meal-worm's response to stimuli. This study moved into a behavior unit. The same general procedures were followed with other units.

A list of units in the order covered during this school year, follows:

1. Peas and Particles (estimating quantities, ESS)
2. The Microscope
3. Small Things (ESS)
4. Plant Cells Study
5. Animal Cells Study

6. Systems of the Body (bones unit of ESS)
7. Behavior (mealworm study, ESS)
8. Heredity
9. Diseases of the Human Body
10. Parasites
11. Care of the Human Body
  - a. Nutrition
  - b. Cleanliness
  - c. Smoking, Alcohol, and Drugs
12. Chemistry
  - a. Atomic Theory
  - b. Elements, Compounds, and Mixtures
  - c. Chemistry in our Everyday life
13. Water
  - a. As a Compound
  - b. Uses
  - c. Purification and Pollution
  - d. TVA
  - e. Erosion

### OBSERVATIONS AND DISCUSSION

Ten percent of the pupils did not master enough of the material to receive a passing grade. This is quite significant when one considers the fact that about 80 percent of this group had failed to pass science the previous year. Thus, the vast majority of the students tasted success and success seemed to breed success. Attitudes were definitely changed. They had worked very hard and were proud of their work. They showed disappointment instead of defeat when they made mistakes.

Any harmful effects of grouping the children were not manifested. The children showed no hesitancy in expressing themselves before their group, no matter how poor their expression. When they knew something, they wanted to tell everyone about it.

The heterogeneous control group (Group 1) made neither the achievement nor progress that the slow group made although they received the same type of material. The gifted pupils in Group 1 were not sufficiently challenged, yet they dominated the class. In heterogeneous grouping the average and below average pupils were not challenged to leadership. The slower students just sat in the classroom, remaining quiet and not actually becoming a meaningful part of the activity.

The students in the slow group were perfectly contented and bragged about their accomplishments. The work they actually did with their hands was of much better quality than similar work performed by the gifted students. For example, the slow group had no difficulty in assembling the chicken skeleton. They had to put it together several times, due to glue failure, but it did not bother them at all. With the gifted children, if the wing bone did not fit properly, it was either the fault of the chicken or of the teacher. They were actually unable to complete the operation. Several of the students in the slow group progressed enough to work in an average classroom. We attempted transfers, but they refused to go.

The example of the digestive system study was given to illustrate the

great depth of study that this program offers. Strange as it may seem, the slow group demanded depth in their study. It is not understood whether this was due to an increased interest or to the realization that they had not learned this material in the past.

The slow group contained the artist. Their art work was remarkable. Many of the microscope drawings were better than those in the science textbook. The lab write-ups were well done and usually highly illustrated with drawings.

It was not the purpose of this program to track the child in a group of this type until he finished school. It was obvious that because of insecurity such children will not perform as an average child until they have gained self-confidence. They will not gain self-confidence through a watered-down science course. They have to know that they are achieving at grade level. The secret to this accomplishment lies in using their strength areas to overcome areas of weakness.

From a teacher's standpoint, working with a slow group in one class is hard. It requires at least twice as much preparation as with an average group. The teacher cannot relax one second in class and neither can he relax between classes because the pupils are always seeking aid in solving problems. Since they have been able to achieve, the teacher takes a special place in their lives. In the past, if they had difficulty or trouble in school it made very little difference to them. Now they feel the problems do make a difference to them and they call on the teacher for aid. This is quite rewarding, but in some instances can lead to problems for the teacher.

The success of this program was illustrated by one of the poorest pupils in it when he said, "Until this year, I hated school; now it's not half bad."

# Approach To Physical Science For Upward Bound Students At The Alabama A And M College, Normal, Alabama

Hayward O. Handy  
Department of Physics and Mathematics  
Alabama A and M  
Normal, Alabama

After eight weeks of teaching physical science to a group of Upward Bound students at Alabama A and M College, Normal, Alabama, we have acquired a few ideas that may be useful to teachers involved with similar programs. It is possible that the teaching-learning approaches might suggest directions that future groups might follow.

Undoubtedly, the most important concern should be the product, i.e., the general scientific attitude and concepts developed by the students for whom the program is designed. Both experienced and inexperienced teachers need some guide toward the conception of better ways to reach students who come with very little, if any predisposition to physical science.

How does one teach this course to the disadvantaged student to whom the scientific concept is a foreign language? The answer is to utilize better and more effective teaching methods. The teacher must provide an effective but introductory approach in the presentation of the simple laws of motion, simple machines, atomic structure, the study of planets, electricity, etc. The format of the course might proceed along the lines of planned topics, with the pace being gauged by the enthusiasm and interest of the class, which, of course, is generated to a large extent by the instructor.

The main objective was to convey to the student an understanding of what science is and how scientific knowledge and ideas are acquired. A first step might be to introduce the scientific approach. "Most of our behavior is learned. We are interested in finding out. We are curious. There are many questions asked. Some we find answers for; others we do not. The point is, we must look at the logical side of things in order to better understand the basic laws and behavior of systems in our universe." It is such statements as these which we have stressed in our physical science program for Upward Bound.

Many children who are the victims of inadequate educational opportunity have many scientific concepts, some accurate, others inaccurate. Some are based on observation only, without interpretative reasoning. It seems hardly necessary to argue the importance of one over the other, for each is necessary to the understanding of the scientific concepts: (a) concepts based on observation alone and (b) concepts that involve creative reasoning, beyond observation. The major problem is to get across to the student the degree to which these concepts become associated with each other. Observation and interpretation are complementary to each other. We need both. This special point was demonstrated in two of the initial experiments: the old "black box" experiment and the calculation of one's horse power by climbing a flight of stairs.

In the horse power experiment, one does all these things quite naturally—that is, one runs up steps, one keeps time, one gets weighed. In other words, the student is taught to work with quantities that he is familiar with in his



real experiences. There is usually already a reasonable understanding by the students of what horse power stands for. They can reconstruct and associate this real experience with their previous concepts and experiences in every day living.

Can the same general remarks be made about the atom, the molecule, etc.? How do we know about these things? Let us place an object in a box. We may do what we please with the box: shake it, turn it, roll it, but do not open it. Now describe what is in the box. Here we expose the student to the scientific method which calls for deductive reasoning. Are we justified in saying something about what is in the box? How would you rate the extent and quality of your interpretation? After conducting the experiment, do you wonder whether this investigation has been carried out in a logical way?

It is not possible to study atomic or molecular structure in school laboratories without the construction of some conceptual model. Hence, our atoms and molecules are "black boxes" which we explore in order to predict their physical and chemical properties. The students can generally learn to visualize and construct such imaginary models in their minds.

The student is taught that it is better to have a wrong concept provided it is tested and found to be wrong than to have no concept at all. The development of problem solving and a healthy scientific attitude received special emphasis throughout the course.

During the coverage of many of the topics and experiments, the majority of the participants expressed delight in discovering the simplicity in the topics, which provided a common basis for a continuing curiosity about science. Many expressed enthusiasm about possible careers as physicists and mathematicians, while others remained undecided about their future educational careers.

#### ACKNOWLEDGEMENT

The author wishes to express sincere thanks to Dr. Howard J. Foster of the Department of Physics and Mathematics for helpful comments and a critical review of the manuscript.



## An Improved Cycle-Counting Technique For Zone Refining Systems

Donald L. Gumprecht  
Reichhold Chemicals, Inc.  
Tuscaloosa, Alabama

The need for highly purified chemicals has increased rapidly in recent years. Very pure compounds are frequently required as primary standards in analytical chemistry. Other uses for extremely pure materials include the manufacture of semiconductors, single crystal growth studies and purification of drugs.<sup>1,2</sup>

One method for obtaining highly purified materials is called molten-zone refining. Figure 1 shows a simplified drawing of a zone refining apparatus. The technique is usually restricted to materials melting above 40 C unless a special environment is provided.

Basically, zone refining involves the application of heat through a small filament or coil. This coil travels very slowly down a tube containing the material to be purified. As the heating coil travels down the tube, a molten zone is formed. This molten zone is then re-cooled by a jet of air that follows the heater coil and results in a recrystallization of the molten material. The more pure material tends to crystallize first allowing the impurities to become concentrated in the molten zone. When the molten zone reaches the bottom of the tube, the heater coil is automatically returned rapidly to the top of the tube and the process repeated as often as required. In this manner, the impurities are gradually moved to the bottom of the tube leaving the purified product at the top. When the desired purification has been obtained, the equipment is stopped.

In order to be able to duplicate results from run to run, it is frequently desirable to count the cycles of the heater coil. Since the equipment normally runs 24 hr a day, manual counting is impractical. The time per cycle can be observed and divided into the total time to obtain the number of cycles. However, unexpected events such as a power failure would give erroneous results.

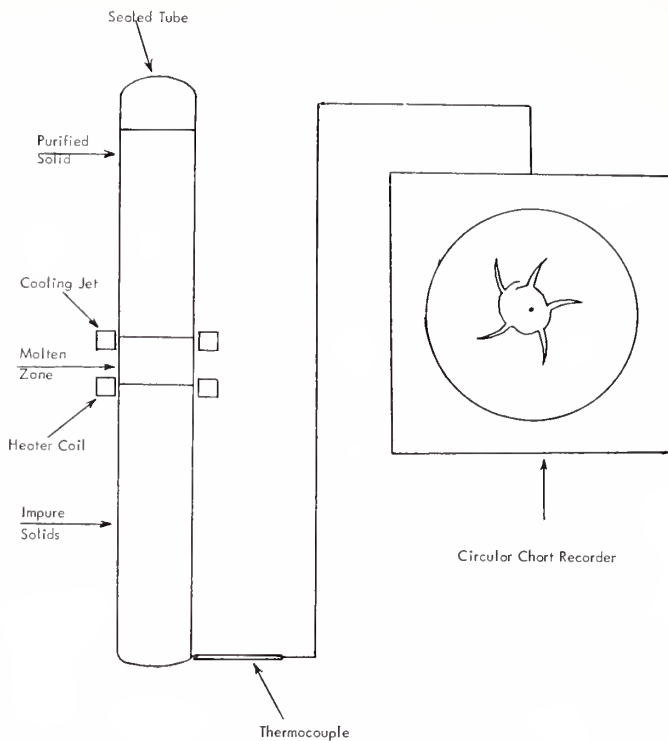
A cycle counter has been described in which a thermocouple is inserted into the top of the tube.<sup>3</sup> The thermocouple is connected to a recorder which shows a temperature rise as the molten zone passes. This technique is satisfactory in many cases but has been found to be impractical when hygroscopic materials are being refined. In this case, a sealed tube is required to keep water out of the system. Any water taken up at the open surface of the tube is distributed through the system and eventually the entire tube becomes liquid.

In recent work on the zone refining of hygroscopic materials such as benzenesulfonic acid and phenol, a new technique has been devised for cycle counting. This technique is readily used with either a sealed or an open tube and has been found to be superior to the one previously used in that very sharp points are obtained on the recorder trace as each cycle is measured.

<sup>1</sup> Friedenburg, R. M. 1963. Ultrapurity and Ultrapurifications of Pharmaceuticals by Zone Refining. Ph.D. Thesis. University of Connecticut.

<sup>2</sup> Parr, N. L. 1960. Zone Refining and Allied Techniques, George Newnes, Ltd. London.

<sup>3</sup> Gumprecht, D. L. 1962. Chemical Engineering. Nov. 26, p. 140.



In this new technique the thermocouple is mounted outside and at the bottom of the tube in a position so that it barely touches the heater coil just as it reaches the bottom of the tube and begins to recycle. In this manner a very short contact time is involved and the result is a sharp, rapid peak on the recorder. In the event of a power failure, both the instrument and the recorder stop. Counting and cycling resume at the same time when power is restored.

Although any type of recorder can be used, we generally have used a circular chart recorder. By using this type of recorder a single sheet of chart paper can be used for many days without any danger of overlapping or obscuring of peaks. Figure 1 shows the thermocouple in the correct position and a typical recorder chart with the type of peaks obtained.

This technique has been used successfully in our laboratories for a number of extended refining runs with no problems. The materials examined have included *o*-phenylphenol and *p*-phenylphenol (both non-hydrosopic compounds) and phenol and benzenesulfonic acid (both hydrosopic compounds). Through the use of zone refining we have been able to prepare phenol having a purity of 99.92 mol percent and benzene-sulfonic acid of 99.6 percent purity. However, we have found that this technique is not applicable to some materials that are unstable at elevated temperatures. For example, repeated melting of pentaerythritol causes some decomposition even in a sealed tube. Based on this experience the use of zone refining equipment is restricted to heat stable compounds melting at 40 C or higher.

## Half-Fertile – Half-Sterile Leaf of *Woodwardia areolata*

Billy J. Williams  
Science Department

George C. Wallace Junior College, Dothan, Alabama

Usually the leaves of ferns serve in both photosynthesis and reproduction. In some species there is a distinct separation of these functions. Some leaves are dimorphic, having strictly photosynthetic and sterile fronds, whereas others are non-photosynthetic and fertile. Such a condition occurs in the net veined chain fern, *Woodwardia areolata* (Fig. 1).

On November 24, 1967, a representative of this species was collected from a marsh three miles south of Pinckard, Alabama. The specimen possessed a leaf that deviated from the norm. The left side of the rachis contained all fertile pinnules, whereas the right side of the rachis possessed all sterile photosynthetic pinnules (Fig. 2).

Dr. Murray Evans, Curator of the Herbarium at the University of Tennessee, in charge of gathering data for the fern section of the southeastern flora project, says this condition has been reported in three other genera: *Blechnum*, *Osmunda*, and *Onoclea*. According to Dr. Evans, *Osmunda cin-*



*namomea* will produce fertile fronds with basal sterile or apical sterile pinnae sometimes, and *Onoclea sensibilis*, if mowed in the middle of the season, will often put up a wierd array of intermediate leaves.

Spores from the *Woodwardia* frond are being germinated on a sterile, solid, nutrient medium designed for cultivation of fern prothallia.









THE JOURNAL  
OF THE  
ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

VOLUME 40

JULY, 1969

NUMBER 3

LIBRARY  
DEC 10 1971

# Officers of The Alabama Academy of Science 1969-70

		Tenure	Term begins	Term expires
PRESIDENT.....	W. B. DeVal, Jr.	1 year	1969	1970
PRESIDENT-ELECT.....	W. L. Furman,	1 year	1969	1970
SECRETARY.....	G. O. Spencer,	3 years	1968	1971
TREASURER.....	W. F. Arendale,	3 years	1969	1972
EDITOR OF JOURNAL.....	R. F. Askew,	3 years	1969	1972
COUNCILOR OF THE AAAS.....	P. H. Yancey,	3 years	1968	1971
PERMANENT COUNSELOR OF JUNIOR ACADEMY.....	J. C. Thomas,	3 years	1968	1971
ASSOCIATE COUNSELORS OF JUNIOR ACADEMY.....	A. F. Hemphill,	3 years	1967	1970
	J. W. Holland, Jr.,		1969	1972
COORDINATOR OF SCIENCE FAIRS.....	G. O. Twellmeyer,	3 years	1968	1971
SECTION I—BIOLOGICAL SCIENCES				
Vice-President.....			R. W. Sidwell	
Vice-Chairman.....			T. E. Denton	
SECTION II—CHEMISTRY				
Vice-President.....			R. C. Sheridan	
Vice-Chairman.....			David Zatko	
SECTION III—GEOLOGY				
Vice-President.....			T. J. Carrington	
Vice-Chairman.....			J. A. Drahovzal	
SECTION IV—FORESTRY, GEOGRAPHY AND CONSERVATION				
Vice-President.....			E. F. Kennamer	
Vice-Chairman.....			M. K. Causey	
SECTION V—PHYSICS AND MATHEMATICS				
Vice-President.....			R. P. Bauman	
Vice-Chairman.....			H. J. Foster	
SECTION VI—INDUSTRY AND ECONOMICS				
Vice-President.....			T. D. Moore	
Vice-Chairman.....			G. T. Stewart	
SECTION VII—SCIENCE EDUCATION				
Vice-President.....			Mrs. Ernest Riggsby	
Vice-Chairman.....			Mrs. Elizabeth Martin	
SECTION VIII—SOCIAL SCIENCES				
Vice-President.....			Aloysius Plaisance	
Vice-Chairman.....			L. Y. Trapp	
SECTION IX—MEDICAL SCIENCES				
Vice-President.....			R. E. Taylor, Jr.	
Vice-Chairman.....			Leo M. Hall	
SECTION X—ENGINEERING				
Vice-President.....			K. M. Pell	
Vice-Chairman.....			M. K. Rich	
SECTION XI—ANTHROPOLOGY				
Vice-President.....			A. T. Hansen	
Vice-Chairman.....			Mrs. Sarah Glass	

## BOARD OF TRUSTEES

W. J. Barrett, Chairman, 1969-'70	J. F. Sulzby, Jr., 1969-'71
E. V. Smith, 1967-'70	F. A. Ross, 1968-'71
J. F. Fagan, 1969-'71	J. F. Voker, 1969-'72
H. M. Philpott, 1968-'71	Lister Hill, 1969-'72
H. E. Carr, 1969-'70	W. B. Jones, 1967-'72
R. V. Miles, Jr., 1967-'70	Walter Bouldin, 1969-'72

# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 40

JULY, 1969

NUMBER 3

EDITOR, pro tem

Robert T. Gudauskas  
Auburn University

ARCHIVIST

Clyde H. Cantrell  
Auburn University

### EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Ann Everett  
Crossville High  
School

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy. The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

## Contents

### ABSTRACTS

Biology and Medical Sciences.....	127
Chemistry.....	160
Geology.....	166
Forestry, Geography, and Conservation.....	166
Physics and Mathematics.....	171
Industry and Economics .....	183
Science Education.....	184
Social Sciences.....	192
Engineering.....	196
Anthropology.....	207

### SYMPOSIA

New Vistas In Biomedical Education.....	149
Some Experimental Approaches To Cancer Control.....	157

ANNUAL BUSINESS MEETING MINUTES.....	213
--------------------------------------	-----

## ABSTRACTS

Papers presented at 46th Annual Meeting  
Mobile College, Mobile  
April 10-12, 1969

### Biological And Medical Sciences

#### Some Observations Of Female Grackle Ethology During The Period Of Nestling Development

Zeno E. Bailey  
Department of Biology  
Livingston University, Livingston, Alabama

Largest of the blackbirds, the boat-tailed grackle (*Cassidix mexicanus prosopidicola*) was first reported in Commerce (Hunt County) Texas in 1949. An annual spring-summer resident, the species has migrated from San Antonio, Texas to as far North as Alva, Oklahoma during the past fifty years.

A phase of the overall life-history study, this investigation was concerned with the ethology of the female during the period of nestling development. During a 16-day-period (June 16-July 2, 1967) the investigator spent 75 hr. observing the females at the nesting site. Nest departures by the females to the quadrants surrounding the nesting site were recorded for 298 such departures. The southern quadrant was used 153 times; the eastern quadrant 123 times. The western quadrant was used 21 times and the northern quadrant was used only once. Fifty-eight per cent of all visits to the nests were made by the females in the morning, while only 42% were made in the afternoon. When only morning visits to the nests were considered, 37% were made by the females before 0645 (DST), while only 20% were made after 0945. But when only afternoon visits were considered, 64% were made to the nests after 1830 and only 36% were made between 1515 and 1715. Time intervals between visits to the nests ranged from a maximum of 44 min. to a minimum of 2 min., the mean time interval being  $15.19 \pm .94$  min. The average number of morning visits per hr. was 4.4, while the average during the afternoon was 4.1 visits per hr.

A fairly predictable pattern of approaching the nest, feeding her young and departing the nest was established by the female during the first week of observation. Though trees were located near the nesting site, females flew directly from the feeding area to cattails (*Typha*) near the nest location. Alighting 6 to 8 ft. from her nest, she would remain 30 to 60 sec., then fly to within 2 to 4 ft. of her nest and remain for 20 to 30 sec. She would then move up to her nest, alight on the eup rim and feed her young within a period of about 60 sec. and then depart promptly to the feeding area. Fecal sacs were removed from the nests by the females and dropped into the water some distance from the nesting site. No fecal sacs were dropped at the nesting site or upon the ground surrounding the pool.

## Changing Iodine Kinetics Due To Variations In Dietary Iodine

R. J. Beschi, George E. Dailey, III, and J. A. Pittman, Jr.

Nuclear Medicine Department  
University of Alabama, Birmingham, and VA Hospital

Normal values for thyroidal radioiodine uptake in central Alabama were first determined in 1959 by the Nuclear Medicine Service at the Birmingham Veterans Administration Hospital. At that time the 24-hr. radioiodine uptake on 63 euthyroid subjects was  $28.6 \pm 6.5\%$  (mean + S.D.). Reassessment of normal values in 1968, using the same instrument, phantom, and 30 similarly selected subjects revealed a mean 24-hr. value of  $13.2 \pm 4.7\%$ .

Further evaluation of iodine metabolism in these individuals indicated normal PBI; however plasma inorganic iodide, absolute thyroidal  $^{127}\text{I}$  uptake and daily urinary iodine excretion were approximately 10, 3 and 4 times greater, respectively, than recently published values.

Complementary studies pointed to bread as a significant contributor of iodine in the diet. Three of more than a dozen iodine-containing components used in a new bread-making process are particularly rich in iodine, namely: yeast food, flour, and milk substitutes. Calcium iodate which is added as a "dough conditioner" contributed less than expected to the total iodine content. The introduction of this "continuous mixing" process which allows the preparation of two to three tons of dough at a time was begun around 1961 and is now in widespread use in central Alabama.

Our data indicate that the low thyroidal radioiodine uptake now obtained in the Birmingham area is the result of a very high intake of dietary iodine; this diminishes the value of the RAI uptake in the diagnosis of hypothyroidism and may significantly disturb thyroidal iodine economy.

## Cementum Annuli Versus Tooth-Wear Aging Of The White-Tailed Deer, *Odocoileus virginianus* (Zimmermann), In Alabama

Reuben B. Boozer  
Jacksonville State University  
Jacksonville, Alabama

A collection of 1,030 white-tailed deer, *Odocoileus virginianus* (Zimmerman), jaws was made during 1967, 1968, and 1969. Of this total, 312 jaws previously aged by the tooth eruption, development and wear-aging method, and representing 22 management areas in Alabama were selected for histological preparation and study. From these selected jaws, over 1,000 microslides were prepared for aging analysis by the cementum annuli aging method. There were only nine known-age specimens available for study. Four were pen reared and five were tagged, released, and subsequently collected in the field.

Alternate light and dark zones (annuli) occurred in the first molar cementum of all deer teeth examined. The alternating light-dark zones corresponded chronologically to annual events or seasons, and were referable to age. The age of the deer was determined by counting either the light or dark zones.

Results of the comparative aging study showed 72% over all age agreement, and 88% age agreement within plus or minus one year. In this study, the cementum annuli aging method appeared to be more accurate and reliable than the tooth wear aging method.



## Nathan Bozeman

Emmett B. Carmichael  
University of Alabama Medical Center  
Birmingham

Nathan Bozeman was born in Butler County, Alabama on March 26, 1825. He received the M.D. degree from the University of Louisville in 1848 and opened his office for the practice of medicine in Montgomery, Alabama. He came under the influence of Dr. J. Marion Sims who had been the first surgeon to cure Vescco-Vaginal fistula while practicing at Mt. Meigs, Alabama. Dr. Bozeman became interested in the operation and made an improvement in the technique by substituting "the button suture" for Dr. Sims' clamp suture. In 1859, Dr. Bozeman visited Europe and demonstrated his methods of operations in England, Ireland and Scotland. On his return, he located in New Orleans, but his stay there was short due to the Civil War. He served as a surgeon under General Beauregard's command. After the War, he settled in New York City where he enjoyed a large and lucrative practice. He spent some two or three years in France and Germany performing his operative techniques. One of the reports of his operations in Germany denominated Dr. Bozeman, "the greatest gynecologist in the world." In 1878, he was appointed surgeon to the New York State Women's Hospital but resigned the position after ten years to establish a private practice. He improved on surgical techniques and invented both a self-retaining vaginal speculum and an operating chair for the knee-chest position.

Dr. Bozeman took an active part in the Medical Association of the State of Alabama from 1850 until he left the state in 1858. He was elected a third vice-president in 1855 and served as a correspondent after he moved to New York City. Dr. Bozeman died of apoplexy on December 16, 1905. He was buried in Macon, Georgia.

## The Oaks In Alabama

R. C. Clark  
Spartanburg Regional Campus  
University of South Carolina

At present, there are 28 species and 4 additional varieties of *Quercus* known to occur within Alabama. *Q. alba* L., *Q. stellata* Wang. and *Q. marilandica* Muenchh. are widespread in the eastern United States and occur throughout Alabama. *Q. phellos* L., *Q. nigra* L. and *Q. falcata* Michaux also are widespread in the State, but have centers of distribution in the Southeast. *Q. falcata* var. *pagodaefolia* Ell. is less common than the typical variety, though sympatric with it. *Q. shumardii* Buckley, *Q. velutina* Lamarck, *Q. rubra* L. and *Q. prinoides* var. *acuminata* (Michaux) Gleason are widespread eastern oaks which reach distributional limits in southern Alabama. *Q. prinoides* Willd. var. *prinoides* is quite rare in the State. Southern Appalachian oaks with distributional limits in Alabama include *Q. montana* Willd. and *Q. coccinea* Muenchh.

*Quercus* rarities include *Q. macrocarpa* Michaux, *Q. georgiana* Curtis, *Q. bicolor* Willd. and *Q. imbricaria* Michaux.

Both *Q. durandii* Buckley and *Q. durandii* var. *austrina* (Small) Palmer occur. *Q. nuttallii* Palmer, a Mississippi embayment taxon, is occasional in western Alabama. *Q. arkansana* Sargent is rare but locally abundant in south-

central Alabama. *Q. virginiana* Miller, *Q. pumila* Walter, *Q. chapmanii* Sargent and *Q. myrtifolia* Willd. are confined to the outer Coastal Plain.

*Q. incana* Bartram, *Q. laevis* Walter, *Q. laurifolia* Michaux, *Q. prinus* L., *Q. lyrata* Walter and *Q. stellata* var. *margaretta* (Ashe) Sargent are widespread in the Southeastern and Alabaman Coastal Plain; several of these also display significant range extensions northward.

Taxonomic problems present include the *Q. stellata* var. *margaretta* — *Q. chapmanii* — *Q. durandii* complex, and widespread introgression in certain red oak populations.

## Interspecific Compatibility In *Vicia*

E. M. Clark

Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Crosses were attempted between 25 species of *Vicia*. An albino hybrid was obtained between *V. villosa* and *V. dasycarpa*. The other species between which crosses were obtained were members of a sativa-like group. They included *V. sativa*, *V. serratifolia*, *V. legumyana*, *V. calcarata*, *V. cornigera*, *V. angustifolia*, *V. macrocarpa*, all with a chromosome number of  $2n=12$  and *V. cordata* and *V. amphicarpa* with  $2n=10$ . Hybrids between  $2n=12$  species generally showed a slight increase in sterility over that of the parents whereas  $F_1$ 's between  $2n=10$  and  $2n=12$  species showed a high degree of sterility.

## Maintenance Of An Albino Interspecific Hybrid In *Vicia* By Grafting

E. M. Clark

Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

The  $F_1$  of an interspecific hybrid *Vicia villosa*  $\times$  *V. dasycarpa* was albino and did not live beyond the seedling stage. By grafting a normal green *V. villosa* shoot onto the stem of the  $F_1$  albino seedling, growth of albino branches was obtained. The albino part developed to floral bud formation. Microspores were examined and meiosis was found to be as regular as that of *V. villosa*.

## Application Of A Microhumidity Chamber To Inoculation Of Peanut Leaves With *Cercospora*

E. M. Clark and J. A. Lyle

Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Satisfactory leaf spot infection was obtained by spraying peanut leaves with a spore suspension of *Cercospora arachidicola* and immediately enclosing them with a plastic bag that remained in place for 72 hr before being removed. The technique was used for inoculation of the whole plant, for one branch and for a single leaf. Equally successful was the inoculation of excised leaves maintained in petri-dish humidity chambers. Pots and petri dishes were maintained in a growth chamber on a schedule of 13 hr light at 80 F and 11 hr

dark at 70 F. Light intensity was about 1300 ft-c. Under these conditions disease lesions were well defined and could be counted 12 days following inoculation.

## Effects Of Magnesium On Banding Density Of Mouse Liver Mitochondria

George B. Cline, Martha Dagg, and Richard Ryel  
Department of Biology  
University of Alabama, Birmingham

The study of subcellular particles requires eventually that they be separated from other cell components in a purified form. The technology for such separations presently utilizes one of several zonal centrifuge rotor systems. When large numbers of particles are packed into zones in these rotors, however, ions such as magnesium can seriously affect separation and purification by causing aggregation. This aggregation problem is particularly important in continuous sample-flow collection of gram quantities of mitochondria and membranes from large volumes of dilute liver brei. Our studies in both the Model K-II continuous sample-flow and the B-XIV batch sample zonal rotors suggest that optimal separation and recovery of mitochondria and membranes from mouse and rat liver brei can be achieved in the absence of buffers or ions in sucrose density gradients. B-XVI studies with flat discontinuous gradients show zones after 3 hr at 30,000 rpm centered at 41.9, 42.7, 43.5, 44.2, 45.1 and 47.1% sucrose. Most of these same zones are recovered from the K-II continuous flow rotor after 3 to 5 liters of dilute liver brei are pumped through the rotor over flat discontinuous gradients at 20 liters per hr at 20,000 rpm. Addition of magnesium to the gradients causes a shift in banding density of several of the components. Mitochondria band lighter in magnesium-containing gradients. Preliminary electron microscope studies suggest the primary mitochondrial zone is centered in 43.5% sucrose when no magnesium is present. However, mitochondria are also present outside of this zone.

## Effect Of s-triazine Herbicides On The Growth Of Excised Roots And Callus Tissue

Leonard G. Copping and D. E. Davis  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Excised roots from corn (*Zea mays* 'Dixie 18') were grown in media containing various concentrations of prometryne (2,4-bis(isopropylamino)-6-(methylthio)-s-triazine). Callus tissue from the cotyledons of soybean (*Glycine max* 'Acme') was grown in media containing various concentrations of prometryne and atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine). Concentrations of atrazine and prometryne from  $10^{-5}$ M to  $4 \times 10^{-4}$ M strongly inhibited growth of callus tissue in the dark. Prometryne was more toxic than atrazine. Concentrations of atrazine below  $10^{-5}$ M stimulated callus growth and an increase in the percentage of nitrogen in the callus with increasing atrazine concentration was found. These effects were not seen with prometryne. Prometryne stimulated root growth at concentrations from  $2 \times 10^{-6}$ M to  $2 \times 10^{-5}$ M and was strongly inhibitory at  $4 \times 10^{-5}$ M and above.

## Biogenesis: A New Theory

F. E. Cole

Department of Biochemistry  
LSU Medical School, New Orleans  
and

E. R. Graf

Department of Electrical Engineering  
Auburn University, Auburn, Alabama

The concept of spontaneous generation is examined in terms of the hypothesis of planetary resonance originated by the authors. This hypothesis, based upon fundamental electromagnetic phenomena, describes a particular phase in planetary evolution occurring between their formation and the development of surface features to the degree that their cooling rates were markedly attenuated. The hypothesis maintains that a planet with a rotation sufficient for the formation of a magnetic field will foster an electromagnetic phenomenon wherein the planet-charge-layer cavity actually constitutes a vast, concentric, spherical resonator functioning within a natural oscillator excited by the magnetic fields and associated van Allen belt currents, which may be active for a long period after its emergence.

The existence of a planetary resonator active within the earth-charge-layer cavity during the Precambrian era and afterwards presupposes that the first terrestrial organisms emerged under conditions markedly different than heretofore hypothesized, for it indicates the existence of an environment in which unique electromagnetic phenomena are the dominant characteristics. A model of the Precambrian earth conceived as a planetary resonator is proposed to illustrate the general physical theory and the discussion of planetary resonator phenomena.

Chemical and physical properties of peptidic and particulate materials formed in experiments designed to simulate the electromagnetic characteristics predicted by the hypothesis are presented.

## Effects Of $N_2$ - $CO_2$ -He Laser Energy On Water Hyacinths

Richard Couch, John Ehrlich, and Thomas A. Barr, Jr.  
Athens College, Athens, Alabama; and

U.S. Army Missile Command, Redstone Arsenal, Alabama

In May, 1968, selected aquatic plant species were exposed to  $N_2$ - $CO_2$ -He laser irradiation. The exposed plants exhibited two responses. The first was an immediate, visible plasmolysis, then burning, of the irradiated plant tissue, directly proportional to the amounts of laser energy applied. The second response was endogenous-systemic in nature. Six to eight weeks following treatment, the plants turned brown, died, and sank. This response was reported to be inversely proportional to amounts of laser energy applied. These results indicated the potential use of laser energy for controlling certain aquatic plants.

Experiments were initiated in November, 1968, to further determine the optimum power-density for the control of water hyacinth (*Eichhornia crassipes* (Mart.) Solms). These tests utilized fall-collected water hyacinths which were held in a greenhouse following laser irradiation. The plasmolysis, then burning, of the irradiated plant tissue was again observed to be directly proportional to amounts of laser energy applied. The systemic-endogenous response was not observed in these experiments except at very high rates. As is the case with

the use of many herbicides for controlling plant growth, physiological age seems to be a factor in the utilization of the  $N_2$ - $CO_2$ -He laser system. Experiments to determine the relationship of physiological age to laser irradiation susceptibility are forthcoming. (This work was supported by the U.S. Corps of Engineers, Department of the Army, Mobile District, Mobile, Alabama, under contract number DACW01-69-C-0020.)

### **Influence Of The Herbicide Trifluralin On Spore Production And Germination Of *Fusarium oxysporum* f. *vasinfectum* In Soil**

E. A. Curl and Anna Tang  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Effects of trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) on production and germination of chlamydospores of the cotton pathogen, *Fusarium oxysporum* f. *vasinfectum*, were determined in soil. The herbicide was applied to cultures of the fungus in flasks of previously sterilized sandy loam and clay soils to provide concentrations ranging from 0 to 40  $\mu\text{g/g}$  of soil. Production of chlamydospores was estimated by hemacytometer counts of soil-spore suspensions. Fungistasis of chlamydospores was assayed on trifluralin-treated sterile and nonsterile clay soil, and the influence of the herbicide on microbial populations in fresh sandy loam and clay soils was determined.

The herbicide, at all concentrations, induced greater chlamydospore production than in the herbicide-free check. The highest spore production was at the lowest trifluralin concentration (0.6  $\mu\text{g/g}$ ), and the lowest production was in the 40- $\mu\text{g}$  treatment. Effects in sandy loam and clay soils were similar, except that more spores were produced in clay soil. In the fungistasis tests, the percentage of spore germination was generally higher for all trifluralin treatments than for the checks, the highest percentage being in the lowest (2  $\mu\text{g/g}$ ) treatment. The general pattern of effects was similar whether in sterile or natural soil. Microbial populations also generally increased in the lower herbicide treatments and declined at higher concentrations.

Results indicated that trifluralin used at approximately field rates may enhance chlamydospore production and germination in soil under a specific environment. The effects seemed to be direct and not significantly altered by fluctuating microbial populations.

### **Age Changes In The Metabolic Profile**

Eleanor L. Downey and Albert E. Casey  
Memorial Institute of Pathology  
Birmingham, Alabama

Among 11,718 metabolic profiles on hospital patients, statistically significant variations in blood constituents were found. The patients were divided into four major age categories — growth, ages 0-17, (200 patients); early maturity, ages 18-28, (824 patients); middle age, ages 29-69, (8,986 patients); and senility, ages 70+, (1,708 patients). The values given are medians for each blood constituent.

In the growth period, there were elevations in the leucine aminopeptidase, 163 GRU; alkaline phosphatase, 12.5 KAU; inorganic phosphorus, 4.5 mg; calcium 9.7 mg; albumin, 3.56 gm; and a low value of cholesterol, 100 mg.



Young adults, had a cholesterol of 197 mg and low levels of transaminase, 25 IU; LDH, 86 KAU; uric acid, 5.0 mg; gamma globulin, 1.31 gm; and blood sugar, 92 mg. In middle age, cholesterol was 217 mg; LDH 94 KAU; transaminase 26 IU; alkaline phosphatase 7.3 KAU; leucine aminopeptidase 134 GRU; blood sugar 96 mg; uric acid 5.3 mg; inorganic phosphorus 3.6 mg; calcium 9.4 mg; albumin 3.23 gm; and gamma globulin 1.30 gm. In old age, cholesterol was 219 mg; LDH 104 KAU; transaminase 28 IU; alkaline phosphatase 8.7 KAU; leucine aminopeptidase 141 GRU; blood sugar 104 mg; BUN 19 mg; uric acid 6.1 mg; inorganic phosphorus 3.5 mg; calcium 9.3 mg; and albumin 3.04 gm.

No age variations were noted for cephalin flocculation, 0 units; thymol turbidity, 1 unit; beta globulin, 0.78 gm; alpha<sub>1</sub> globulin, 0.36 gm; alpha<sub>2</sub> globulin, 0.81 gm; C92, 26 mEq l; potassium, 4.1 mEq l; chloride 101 mEq l; amylase, 94 units; CPK, 0.2 units; and bilirubin 0.5 mg.

## The Status Of The Wood Stork In Alabama, 1968

Rosemary T. Dusi  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

In Alabama, the wood stork, *Mycteria americana*, is known as a common summer resident. As early as 1891, a specimen was captured near Greensboro. A nesting colony was not located until June 1968.

The wood stork is the only true stork found north of Mexico, in the Western Hemisphere. The impressive bird stands almost four ft high; the body is covered with white feathers; the flight feathers of the wing and tail are black with iridescent greens and purples; the neck and head are naked, dark grey skin; the bill is grey, shaped like a dagger. On the ground it is an ungainly creature but when the strong five and one-half foot span wings lift it into the air, with alternate flapping and sailing motions, it may ascend to heights of about 5,000 feet. Soaring, there is no comparison with the beauty and graceful gliding flight, as they ride the rising air currents.

The crude, bulky, stick nest that it builds is perched in the tallest trees of the swamp or marsh area in which the rookery is located. This type of habitat discourages man's approach to the nesting area on foot, but the use of an airplane makes this habitat easier to study.

On June 20, 1968, while J. L. Dusi and I were flying a routine population density and distribution transect, we saw and photographed a colony of wood storks, about one mile southwest of Hardaway, Macon County, Alabama. On July 23, we were able to approach the Hardaway swamp on foot, wading into the nesting area and photographing the birds protectively standing near their nests and on this basis claim this as a probable breeding record for the state.

## Cytological And Cytochemical Studies On The Sporozoites Of *Eimeria stiedae*

John C. Frandsen  
USDA Regional Parasite Research Laboratory  
Auburn, Alabama

Activity of acid phosphatase was demonstrated with both naphthol AS-BI phosphoric acid and the *p*-toluidine salt of 5-bromo-4-chloroindolyl phosphate



as substrates. Using the same substrates, alkaline phosphatase activity was not detected.

The presence of carboxylic ester hydrolases (with either naphthol AS-D acetate or 5-bromo-4-chloroindoxyl acetate as substrate), "leucine aminopeptidase" (not necessarily E.C. 3.4.1.1) (with either L-leucyl-4-methoxy-*b*-naphthylamide or L-N-(5-bromoindol-3-yl) leucinamide hydrochloride as substrate, *b*-glucosidase (3-(5-bromoindolyl)-*b*-D-glucopyranoside as substrate), and *b*-galactosidase (with 5-bromo-4-chloro-3-indolyl-*b*-D-galactoside as substrate) could not be detected. Activity of lactate dehydrogenase (E.C. 1.1.1.27) and glucose-6-phosphate dehydrogenase (E.C.1.1.1.49) was detected, primarily in perinuclear sites in the cells.

The apparent distribution and abundance of lipids varied according to the cytochemical technique utilized for their detection — oil red O, sudan black B, or 3,4-benzpyrene. Only a few small sites were stained with oil red O, whereas fluorescence with 3,4-benzpyrene was observed in several loci.

Staining with gallocyanin chrome alum for nucleic acids revealed a significant amount of stainable material in the posterior fifth of many cells. Vital staining with Janus green B resulted in coloration of some small bodies in the nuclear region. Only with azure-A, eosin B and periodic acid-Schiff Alcian blue staining does the refractile globule show indication of internal structure. The refractile globule is also argentophilic.

## An Analysis Of Serum Proteins Of An Inbred Strain Of Mice

J. Don Franks  
Birmingham-Southern College  
Birmingham, Alabama

A new inbred strain of laboratory mice, designated PBA (Paul Bailey Albino), and listed in *Inbred Strains of Mice*, No. 5, has been developed by Paul Bailey of Birmingham-Southern College. This strain develops three spontaneous neoplasms: a lymphoma, a mammary tumor, and a pulmonary adenoma. Serum proteins from tumor-bearing animals (lymphoma) of the PBA strain were studied by means of electrophoresis using cellulose acetate as the supporting medium. Two "normal" inbred strains (C57 B1/6J and PBB) were studied as controls.

Results of this project indicated that there is an increased amount of gamma globulin in the serum of some of the lymphoma-bearing PBA mice. A 12 month study of a group of 50 PBA mice, with sampling done at four week intervals, revealed that, once the mice attained an abnormal amount of gamma globulin, the level was either increased or maintained until death of the animals. A study of animals with tumors in various stages of development failed to show any correlation between tumor size and increased amounts of gamma globulin. Although there was no correlation between tumor size and increased amount of gamma globulin, there was a correlation between the pathology of these animals and the abnormal gamma globulin fraction. Animals that showed an increased amount of gamma globulin also showed a marked increased proliferation of plasma cells in the lymph nodes and spleen.

## A Taxonomic Study Of Members Of The Genus *Flavobacterium*

Shirley E. Gunter  
Department of Microbiology  
University of Alabama, University

Over 60 cultures of bacteria whose characteristics conform to those of the genus *Flavobacterium* have been isolated from soil and water. This genus as a whole has been neglected but recent studies indicate that these bacteria may play an important role in preservation of fish and the biological degradation of herbicides and other organic compounds in nature. The organisms are gram negative, predominantly non-motile rods which produce yellow or orange, non-water soluble pigments. The motile strains exhibit a limited number of peritrichous flagella. Physiologic characteristics such as the nutritional requirements, type of energy metabolism, oxygen requirements, optimum pH and temperature, range of carbohydrate utilization, ability to degrade proteins and responses to common biochemical tests were studied. All strains exhibited similar general growth requirements. However, a variety of combinations of responses were obtained in the biochemical tests. It was possible to divide the cultures into eight groups by restricting the number of tests used for differentiation but only one group fit the description of an established species. The differentiation of species and the question of relationships with the genera *Pseudomonas*, *Achromobacter* and *Cytophaga* will require further investigation for a satisfactory resolution.

## Morphometric Variability Of *Rotyleuchulus reniformis*, The Reniform Nematode

Ching Tuen Hung  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

The extensive host range and wide distribution of this plant parasitic nematode suggest the occurrence of biotypes and that the present morphological criteria for the species may be inadequate. Numerous standard and additional morphometric characteristics were measured and compared within and between populations from several distantly separated sources.

Character variability within the progeny of a single isolate about equalled the range of variability of random samples of an Alabama population. Tail shape and length and tail annule numbers in this population varied so extensively that their continued use as diagnostic characters is doubtful.

Comparison of Alabama, Texas, Taiwan, and Hawaii reniform nematodes revealed that only the Hawaii population had several distinct morphometric values including longest esophagus, highest V-value, longest excretory pore to vulva distance, most tail annules, longest hyaline area in tail, and longest tail. Most obvious were larger length and short lip height. The other populations had fewer distinctive morphometric values than the Hawaii population, e.g., the Texas population exhibited a short body length but had the widest body and the Taiwan population had relatively short esophagi and short distance from stylet base to dorsal gland orifice.

All the populations appeared to have a wide range of variability and overlapping values in most standard morphometric characters. Only a few of the V-values, stylet length, and dorsal gland orifice are limited variability. New

measurements that seemed to represent less variable characters were the distances from excretory pore to vulva, and from excretory pore to anus.

The morphological variability of reniform nematodes was unexpectedly wide and thus far only the Hawaii population could be a distinct morphological biotype.

## The Testate Amoebae Of Langan Pond, Mobile, Alabama; A Preliminary Study

E. E. Jones and James Newberry  
Department of Biological Sciences  
University of South Alabama, Mobile

Langan Pond located in Mobile's Municipal Park was established in 1950. The ecology of the pond has never been studied. This preliminary survey of the testate amoebae is the beginning of such a study.

The pond contains a variety of testate forms with the genus *Diffugia* comprising approximately 75% of the total number of species. The genera *Arcella*, *Centropyxis*, and *Euglypha* make up the remaining 25%. It was found that most testate forms were more prevalent in areas which were protected from the sun and were sites of active bacterial decomposition. A distribution scheme is presented listing the areas in which each species was observed and its relative abundance in those areas.

## Mechanism Of Non-Pancreatic Tumor Hypoglycemia: Inhibition Of Gluconeogenesis

R. A. Kreisberg, J. M. Hershman, B. R. Boshell, J. Spenny, and L. Pennington  
Department of Medicine  
University of Alabama Medical Center, Birmingham

There is no satisfactory humoral or biochemical explanation for the hypoglycemia associated with non-pancreatic tumors. To determine the roles of increased utilization and decreased production of glucose, we studied glucose and lactate kinetics by isotopic techniques in a patient with hypoglycemia and Cushing's syndrome due to an adrenocortical carcinoma. 100 $\mu$ c of glucose-1- or 1-lactate-1-<sup>14</sup>C were administered by a priming-constant infusion technique before and after removal of the tumor. Turnover (T), recycling (R), endogenous glucose production (EP), glucose conversion to lactate (G<sup>L</sup>), lactate conversion to glucose (L<sup>G</sup>), and oxidation (CO<sub>2</sub>) were determined.

### Glucose (mg./Kg./hr.)

	T	R	T-R	EP	G <sup>L</sup>	CO <sub>2</sub>
Before	323	21	302	21	193	52
After	133	17	116	133	85	20

### Lactate (mg./Kg./hr.)

	T	L <sup>G</sup>	CO <sub>2</sub>
Before	221	8.8	51
After	89	14.2	29

Before surgery, the turnover, oxidation, and conversion of glucose to lactate was markedly increased. Endogenous glucose production was low and gluconeogenesis from lactate was decreased. After surgery, glucose turnover and endogenous glucose production returned to normal and gluconeogenesis from lactate increased. These results indicate that the hypoglycemia in this patient was due to a combination of increased glucose utilization and decreased glucose production.

## The Influence Of Park Development On The Native Plants Of Little River Canyon

Kenneth Landers, Richard Ambrose, and Norman Harris  
Jacksonville State University  
Jacksonville, Alabama

The development of Little River Canyon as a park and tourist attraction has resulted in the destruction of plants that are quite rare in Alabama. The largest colony of *Fothergilla major* (Sims) Lodd. known in the area has been completely removed in the construction of a skylift and picnic area. Colonies of *Iris cristata* Ait., *Physocarpus opulifolius* (L.) Maxim., *Pyrularia pubera* Michx. and a number of other plants such as *Stewartia ovata* (Cav.) Weath. have been disturbed or destroyed. The construction of a new road from Eberhart Point to Little River Canyon Mouth Park will probably result in the destruction of population of rare plants. This natural area is very valuable to scouts, camping parties, various school groups and college classes as well as other individuals interested in surroundings relatively free of domestic plants, various food containers, wrecked cars and names and slogans painted on rock formations.

Steps should be taken to preserve the native plants and wildlife of the area against lack of supervision or poor supervision by park employees and the encroachment of portions of this state property by leasing agreements with private individuals. This is especially important since such a high percentage of private land in Alabama is either not open to groups interested in natural areas or the native plants have been disturbed or removed and the land planted to crops and pine trees.

## A Survey Of The Flora Of Little River Canyon

Kenneth Landers, Thomas Cochis, and Jerry Clonts  
Jacksonville State University  
Jacksonville, Alabama

Little River Canyon of Alabama has an interesting and varied flora. The plants of the dry, sandy areas of the canyon mouth and the outcrops are quite different from the vegetation of the banks of Little River and the rich alluvial woods of the cool, moist, north-facing slopes. Species such as *Pyrularia pubera* Michx., *Veratrum parviflorum* Michx., *Iris cristata* Ait., and *Stewartia ovata* (Cav.) Weath. are found in the rich woods and moist areas. Plants of the dryer areas and outcrops include *Quercus stellata* var. *margaretta* (Ashe) Sarg., *Quercus incana* Bart., *Schoenolirion croceum* (Michx.) Gray, *Iris verna* L., and *Arenaria groenlandica* (Retz.) Spreng.

The vegetation of Little River Canyon has not been studied extensively

even though a number of individuals, biology classes, and clubs visit the area frequently. A thorough investigation of the vegetation would be valuable to laymen and scientists visiting and studying the area.

### Suitability Of Soybean Host For The Lesion Nematode, *Pratylenchus brachyurus*

Donald W. Lindsey  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Effects of soybean cultivars and temperature on reproduction and pathogenicity of the lesion nematode, *Pratylenchus brachyurus*, were determined. 'Custer,' 'Hill,' 'Hood,' and 'Pickett' were inoculated with 100 *P. brachyurus* per plant and grown in the greenhouse at 13, 21, and 29 C for 30 days. Roots were harvested, stained in a mixture of lactophenol and acid fuchsin, and the number of nematodes and eggs in the roots counted.

Roots of Custer, Hood, and Pickett plants contained highest nematode populations at 29 C, and lowest at 13 C. Population in Hill roots were highest at 21 C, slightly less at 13 C, and least at 13 C. Roots of Pickett plants contained the highest populations, 428 nematodes and 431 eggs at 29 C; followed by Custer, 298 nematodes and 327 eggs at 29 C; Hill, 146 nematodes and 191 eggs at 21 C; and Hood, 85 nematodes and 60 eggs at 29 C. Nematode populations in roots of Pickett and Hood dropped sharply between 29 and 21 C, but comparatively small changes occurred between 21 and 13 C. Populations in Custer and Hill roots dropped sharply between 21 and 13 C, but comparatively small changes occurred between 21 and 29 C.

Root pruning occurred in all infected cultivars at 29 and 21 C. Roots of Hood were the most severely pruned followed by Pickett, Custer, and Hill, respectively. Data showed no consistent variation occurred in foliage weight, stem length, or root weight at 13 C. There was a general, but not severe, reduction of foliage weight and stem length at 21 and 29 C. Pickett was the only cultivar that showed root-weight reduction at 21 C. Custer had the highest root-weight reduction at 29 C, Hood root-weight reduction was slightly less; and there was no root-weight reduction in Hill or Pickett. Thus, reproduction of *P. brachyurus* and its pathogenicity to soybeans were affected by cultivar and by temperature.

### Aggression In Male White Mice

Pauline King Long  
Jefferson State Junior College  
Birmingham, Alabama

Male white mice are by nature aggressive and could be readily induced to fight fiercely. But at the same time, they do little damage to their opponents unless the fight is prolonged. They were readily controlled and separated. The mice were studied to obtain a normal aggressive reaction for the individual mouse under certain controlled conditions.

Mice of the same litter or from litters born a few days apart were isolated at the same time in metal cages which had wire mesh covers with food hop-



pers and water bottles so that food and water were constantly available to the mice. Shavings were placed in the cages in which the mice remained isolated from each other except during staged encounters. They were transferred to clean cages every two weeks by picking up by the tail by hand and were handled only by the author and only at this time and the time of transference for encounter. The age of the mice at initial isolation varied from 50 to 64 days of age. There was a period of two weeks of isolation before the encounters were begun.

Each mouse was earmarked for purposes of identification. Round-robins of encounters were staged, in which each mouse met every other mouse in the experimental group. The order of encounters was varied so that individuals did not meet in the same sequence in consecutive rounds. Encounters were staged in the wire-cage home of one of the two mice. The two mice were permitted to remain together for a period of ten min. The reactions of the two mice were recorded. Such reactions included: indifference, approach, nose contact, tail contact, lateral contact, active and passive chase, and active and passive fight. These responses were recorded by observation. The fighting response was any striking and/or biting movement by either or both animals toward the other while in a stereotyped fighting position. (A stereotyped position is when the mice face each other in an upright position, with the head thrust forward, the mouth open, and they strike vigorously at each other.) This fighting position was used to work up statistical results on the norm of aggressive behavior for normal male white mice. These norms are to be used for comparative studies for aggressive behavior under abnormal conditions.

The statistical results were derived by obtaining the range, the mean, the variance, and the standard deviation of the numbers of fighting encounters per 10 min. period of time for both of the 13 visiting and of the 13 home mice. The variance provided a measure of the clustering of the individual measurements. Plotting the numbers of encounters with the variance indicated that the home mice were more aggressive than were the visiting mice. One possible explanation was because of the intrusion of the home territory.

The "goodness of fit" was determined by the use of the cumulative chi-square distribution probability level with 12 degrees of freedom for each visit. The significant deviation used was the 50% probability level. The norm for aggressive behavior for normal male white mice under the conditions as outlined above was 1.5 encounters lasting 25.7 sec. per each 10 min. visit. The method used to obtain this norm will be used as a future approach in the study of aggressive behavior of male white mice, both under normal and abnormal conditions.

## **Heavy Metal Protection Of Long Wave Ultraviolet-irradiated Bacteria**

H. A. Lynn

Department of Biological Sciences  
University of South Alabama, Mobile

Bacterial species were irradiated with long wave ultraviolet light for periods ranging from 8 to 12 hr. In the presence of optimal concentrations of various heavy metal salts the bacteria were protected from the otherwise lethal effect of the UV light. Five out of 7 gram-negative species tested were protected by



the ions whereas 6 of 6 gram-positive species were not. It is suggested that cell envelope differences related to the gram reaction are involved in this protective phenomenon.

## Ecology Of Nematodes In A Small Fresh-Water Pond

T. W. Merritt, Jr. and E. J. Cairns  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Benthic nematode population fluctuations and biological, chemical, and physical factors of the environment were studied over a 9-month period at ten selected sampling stations in a small farm pond. Nematode community structure was investigated over a 3-month period.

Variations in pH, dissolved oxygen, and temperature were apparently within suitable limits for survival and growth of the nematodes, bacteria, and fungi and were not extreme enough to directly cause the observed nematode population changes. The single most important factor influencing concentrations of nematodes, bacteria, and fungi in the pond study was the presence of a finely divided, easily disturbed, detrital layer overlying the sand-mud surface. Numbers of micro-organisms, including nematodes, found at the sampling stations with the thickest layers of detritus were consistently higher. Stations with less detritus had fewer deposit feeding nematodes and proportionately more predatory nematodes. The thickest layers of detritus supported a larger variety of nematode feeding types, indicating a fertile habitat with numerous micro-ecological niches. The occurrence of two peaks in the nematode populations in April and December suggests a seasonal influence, but no direct reason for these peaks was evident in the data.

## 3 Phosphoglycerate Kinase: Assay For And Inhibition By ADP

S. Jones Miller and Leo M. Hall  
Department of Biochemistry  
University of Alabama, Birmingham

3-phosphoglycerate kinase, one of the enzymes involved in the anaerobic oxidation of glucose, occupies an interesting position in the glycolytic pathway.

In looking for an assay system for the enzyme in crude tissue extracts, neutralized hydroxylamine hydrochloride was used as a trapping agent for 1,3-diphosphoglycerate. (Bandurski, R. and Axelrod, B., J.B.C. 204, (1953)). However, this was not a suitable assay due to the non-linearity of the products versus the enzyme concentration. It was found that ADP, one of the products of the reaction, inhibited the reaction 47.8% at  $10^{-3}$  M. To overcome the inhibition by ADP, an ATP regeneration system consisting of phosphoenolpyruvate and pyruvate kinase was added to the incubation mixture. With this regeneration system present, it was found that a linear assay for 3-PGA kinase could be obtained for crude tissue extracts. Because of the possible physiological significance of this ADP inhibition, the kinetics of the yeast enzyme were then investigated. Kinetics were measured using the optical assay system at 340 m $\mu$ , measuring the oxidation of NADH with glyceraldehyde-3-phosphate dehydrogenase as an auxillary enzyme, (T. Bücher BBA 1, 292, (1947)).  $K_m$

and  $V_{\max}$  for ATP were determined with and without added ADP to determine the type of inhibition exhibited by ADP.  $K_m = 6.50 \times 10^{-4}M$  and  $V_{\max} = 4.80 \times 10^{-5}$  in the absence of added ADP where  $K_m = 1.28 \times 10^{-3}M$  and  $V_{\max} = 8.69 \times 10^{-6}$  in the presence of  $4.5 \mu\text{moles}$  of ADP. From double reciprocal, Lineweaver-Burk plots, the  $K_m$  and  $V_{\max}$  in the presence and in the absence of ADP are both different indicating an uncompetitive type of inhibition.

These findings with the yeast enzyme led us to investigate this enzyme in mammalian systems. Using rat liver homogenates as a source of this enzyme, we have achieved a 30 fold purification by acetone precipitation followed by Sephadex G-100 and G-200 columns. Our findings indicate that this enzyme has a molecular weight greater than 100,000 compared to 34,000 for the yeast enzyme (Raznikiewics, M.L., and Malstrom, B.B., ABB 92 94 (1961).

These findings suggest that in mammalian systems, 3-phosphoglycerate kinase may be a sub-unit enzyme. The role of this enzyme and its inhibition by ADP in the regulation of glycolysis and gluconeogenesis are under investigation.

## Separation Of Phosphatidyl-Ethanolamine Into Molecular Species

Kathleen Morrison, Joe R. Norman and Hugh L. Spitzer  
University of Alabama Medical Center, Birmingham

Studies of liver lecithin (PC) biosynthesis have shown a correlation between the pathway of synthesis and the unsaturated fatty acid esterified to the C-2 position of the glycerol backbone. Linoleoyl-PC(L-PC)>Arachidonoyl-PC(A-PC)>Docosahexaenoyl-PC(D-PC) is synthesized via the CDP-choline pathway and D-PC>A-PC>L-PC is synthesized via the methylation of phosphatidyl-ethanolamine (PE). Since the biosynthesis of PE takes place via a CDP-ethanolamine pathway or decarboxylation of phosphatidyl-serine (PS); by analogy, one might predict that different molecular species are involved in the two reactions.

The present study was undertaken to separate PE into molecular species. PE from rat liver was purified by silicic acid column and thin layer chromatography (TLC). Separation of PE into molecular species was achieved using  $\text{AgNO}_3$  TLC with the following conditions found optimal: plates were coated with a mixture of 60g Silica Gel G plus 11g  $\text{AgNO}_3$  dissolved in 120 ml water (0.5mm); heated for 2 hr at 150 C directly before use; and developing solvent  $\text{CHCl}_3:\text{CH}_3\text{OH}:\text{H}_2\text{O}$  (125:50:6). The results were:

	$R_f$	16:0*	18:0	18:1	18:2	20:4	22:6
L-PE	0.59	22.6	19.8	14.3	30.9	1.4	0.0
A-PE	0.47	11.9	43.2	2.0	0.0	42.9	0.0
D-PE	0.43	21.2	28.3	2.1	0.0	4.4	43.9
PE		22.7	35.4	4.4	4.5	19.7	12.8

\* Chain length: number of double bands. Value-Moles %.

One major problem in the purification and isolation of PE is rapid oxidative degradation of polyunsaturated fatty acids. To inhibit this oxidation, 0.01%

Santoquin was added to eluting and extracting solvents and nitrogen was employed for evaporation of samples. Using this procedure, purified PE could be stored for 7-10 days without detectable degradation.

## Effect Of The Spiral Nematode, *Helicotylenchus dihystra*, On The Yield Of Five Soybean Cultivars

David P. Orbin  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Five cultivars of soybeans, *Glycine max*, were inoculated with *Helicotylenchus dihystra* at a rate of 5,000 nematodes per seed in the greenhouse. Nematode populations on 'Bragg' and 'D63-7320' increased five-fold during the 90 day test period. Previously, 'Jackson' had shown a similar host suitability, while populations on 'Custer' and 'D64-4636' had remained static or declined. 'Bragg' and 'Custer' showed an average reduction in dry weight of seed of 21.1 and 38.2%, respectively, which was statistically significant at the 10% level. Other cultivars showed no significant difference in yield between the infected and noninfected plants. Infection by *H. dihystra* did not significantly alter the seed protein levels of any cultivars. Although *H. dihystra* reproduced in great numbers on three cultivars and invaded the root cortex in large numbers, it caused significant yield reduction in the case of 'Bragg,' but not in 'Jackson' or 'D63-7320.' The reduction occurred in the presence of nematode populations twice as great as any reported in field surveys of soybeans. Yield reduction in 'Custer' was due to hypersensitivity to the nematode. Results indicate that 'D64-4636' was resistant to *H. dihystra*.

## Effects Of Atrazine On Absorption And Translocation Of $P^{32}$ In Peas

Robert Owen  
Athens College  
Athens, Alabama

This experiment was conducted to test the effects of 0, 1, and 10 ppm 2-chloro-4-ethylamino-6-isopropylamino-s-triazine (atrazine) on the absorption and translocation of radioactive phosphorus ( $P^{32}$ ) in English peas (*Pisum sativum* L.). After 18.5 hr absorption of atrazine and 6.5 hr of  $P^{32}$  tracer, the plants were removed from the flasks, blotted dry, and placed in a plant press for drying. Once dried, three replicate plants were mounted on a single piece of white mounting paper. They were then exposed to Kodak No-screen X-ray film for approximately 4 weeks. Accepted standard techniques were used for both the autoradiography and developing of the autoradiograms.

Visual analysis of autoradiograms, confirmed by Geiger-Muller count analysis, showed that the atrazine treatments used in this experiment reduced the absorption and translocation of radioactive phosphorus in the pea plants. The 10 ppm treatment had the greatest effect on the absorption and translocation of  $P^{32}$  by the roots of peas, but the 1 ppm and 10 ppm treatments were essentially equal in reducing the absorption and translocation of  $P^{32}$  in the stems and leaves of pea plants.

## Effect Of The Herbicide EPTC On Growth And Enzymatic Activity Of *Sclerotium rolsfii*

J. L. Peebles, E. A. Curl, and R. Rodriguez-Kabana

Department of Botany and Plant Pathology

Auburn University, Auburn, Alabama

Effect of the herbicide EPTC (ethyl N, N-dipropylthiolcarbamate) on growth of the Southern Blight fungus, *Sclerotium rolsfii* Sacc., was determined in liquid and soil cultures. In modified Czapek's solution, mycelial production was significantly lower in all treatments with EPTC (10, 25, 50 and 100  $\mu\text{g}/\text{ml}$ ) than in the herbicide-free control. Mycelial reduction and the utilization of glucose, inorganic phosphorus, and nitrate-nitrogen were inversely related to the amount of EPTC added to the medium. Rate of growth and glucose utilization was maximal in the first 3 days for the control, and between the 3rd and 5th days for the herbicide treatments. The economic coefficients, relating amount of mycelium produced to glucose consumed, declined sharply with increasing concentration of the herbicide, indicating a general antimetabolic action of EPTC. Increase in titratable acidity of the culture medium at the two highest herbicide concentrations, and an increase in the ratio of glucose to inorganic phosphorus consumed, suggested action of the herbicide on the respiratory cycle of the fungus.

In soil cultures containing 0, 1.0, 2.5, 5 and 10  $\mu\text{g}$  of EPTC per gram, growth of *S. rolsfii* was measured in terms of its saccharase activity. Saccharase activity increased with time in all soil treatments and the control throughout the 10-day incubation period. Values for the 5- and 10- $\mu\text{g}$  treatments were significantly higher than values for all other treatments and the control, indicating stimulated growth. Economic coefficients relating saccharase activity to glucose removed increased with increase in herbicide concentration.

## Influence Of Carbon-to-Nitrogen Ratio On The Interaction Of *Sclerotium rolsfii* And Atrazine In Soil

Gary Pitts

Department of Botany and Plant Pathology

Auburn University, Auburn, Alabama

A study was conducted to determine the effects of the herbicide atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) on the growth response of *Sclerotium rolsfii* Sacc. in soil with carbon:nitrogen ratios of 10:1 and 50:1. The ratios were provided by supplementing a low-nutrient sandy loam with glucose and  $\text{KNO}_3$ . The soil was sterilized, inoculated with a suspension of chopped mycelium, and atrazine was added at rates of 2, 5, 10, and 20  $\mu\text{g}/\text{g}$  of soil. The culture soil was analyzed at intervals for 20 days to determine removal of nutrients ( $\text{NO}_3\text{-N}$  and glucose), production of acids (titratable acidity, pH, and conductivity), and accumulated exoenzymes (polygalacturonase and saccharase). In the atrazine-free soil with a C:N ratio of 10:1, the fungus grew slowly. Atrazine concentrations of 10 and 20  $\mu\text{g}/\text{g}$  retarded fungal growth slightly, but the effect usually was not statistically significant. Where the C:N was 50:1 the fungus grew rapidly in atrazine-free soil, depleting nutrients considerably in 8 days. Significant differences between treatments were noted after 4 days incubation. At the atrazine rate of 20  $\mu\text{g}/\text{g}$  no fungal growth was indicated at 4, 8, and 12 days, but after 20 days considerable growth had occurred. Lower concentrations were less effective.



## Metabolic Adaptations In Mammalian Brain

C. Andrew Robinson, Jr. and Leo M. Hall  
University of Alabama  
Birmingham

It is generally accepted that glucose is the sole source of substrate for energy production in the brain. However, during periods of fasting or during periods of rapid growth one might expect to find other sources of fuel being utilized by the brain. It has been reported that the enzyme  $\beta$ -hydroxybutyrate dehydrogenase, isolated from rat brain mitochondria, increases in activity during fasting and during early development. (Smith *et al*, Science, 163, 79, 1969, and Klee, *et al*, J. Biol. Chem., 226, 3880, 1967.)

Due to these findings we decided to investigate the oxidation of  $3\text{-}^{14}\text{C}$ - $\beta$ -hydroxybutyrate by developing rat brain mitochondria. We have shown that rat brain mitochondria isolated from rats of 36 hr, 5, 10, 15, 20, 26, 30 day and adults could utilize this compound and it did provide a significant proportion of the energy for brain development. The oxidation of  $\beta$ -hydroxybutyrate reached a peak of  $2.3\text{ }\mu\text{moles/g brain/hr}$  at the 20th day after birth. The newborn and adult levels are 0.355 and  $0.852\text{ }\mu\text{moles/g brain/hr}$ , respectively. This is in contrast to  $2\text{-}^{14}\text{C}$  pyruvate oxidation which rose until the 20th day to a value of  $6.07\text{ }\mu\text{moles/g/hr}$  then remained constant.

After demonstrating that  $\beta$ -hydroxybutyrate could be oxidized by brain we then investigated the enzymes,  $\beta$ -hydroxybutyrate-dehydrogenase and acetoacetate-succinyl CoA-transferase. We found the activities of these enzymes to follow the same pattern as shown by  $\beta$ -hydroxybutyrate oxidation. At the 20th day after birth the dehydrogenase reduced  $28.5\text{ }\mu\text{moles NAD/g brain/hr}$ ; transferase, which was linked to  $\beta$ -hydroxy-Acyl CoA-dehydrogenase oxidized  $27.9\text{ }\mu\text{moles NADH/g/hr}$ . These activities found at the twentieth day were 9.2 times higher than the newborn or adult levels.

Since it has been reported that rat milk contains 14.8% fat as opposed to 4.3% fat in lab chow (Cox, *et al*, J. Natr., 13, 429, 1937). Our findings could indicate an adaptation, during early development to diet.

## Enzymatic Activity In Soil Colonized By *Rhizoctonia solani* or *Fusarium oxysporum* f. *vasinfectum*

R. Rodriguez-Kabana and B. Truelove  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Experiments were conducted to determine activity and properties of catalase and representative hydrolytic enzymes in soil inoculated with pure cultures of plant pathogens, *Rhizoctonia solani* and *Fusarium oxysporum* f. *vasinfectum*. Soil cultures were established in 250-ml Erlenmeyer flasks, each with 100 g (oven-dry basis) of twice-autoclaved Norfolk sandy loam soil supplemented with 10 ml of a filter-sterilized solution containing in mg/ml; glucose 36, N as  $\text{KNO}_3$  0.33, and P as  $\text{K}_2\text{HPO}_4$  0.21. Final moisture content of the soil was 60% of field capacity. The flasks were inoculated separately with mycelial suspensions of the pathogens and incubated for seven days at 27°C. The flask contents were then air-dried at room temperature. The dried soils were stored at 4°C until assayed for enzymatic activities. *Rhizoctonia* soil exhibited more catalase activity (determined polarographically) per mg of air-dried soil than

*Fusarium* soil; catalase activity of both soils did not appreciably change on buffering to pH 7.0. Activity of saccharase (invertase) and alpha-glucosidase was present in *Rhizoctonia* soil but was not detectable in *Fusarium* soil. Both soils showed amylase, beta-glucosidase, esterase (phenyl acetate test), and phosphomonoesterase (phenyl disodiumphosphate test) activity. With the exception of esterase, activity of hydrolytic enzymes in *Rhizoctonia* soil was maximal with range of 5-6, and in *Fusarium* soil in the range of 5.5-6.5. Both soils exhibited maximal esterase activity at pH 7-8.

## Quadrat And Biotelemetric Studies Of The Cotton Rat

Richard A. Roper  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

Data from a quadrat home range study and some early indications of telemetry study were presented. Home ranges were calculated by means of the minimum area, exclusive boundary strip, and inclusive boundary strip methods, and much variation was evident among them. Some commentary was also included regarding the difficulties which are a part of mark-release studies.

Telemetry revealed more locality points over six hr, than was obtained in 14 live-trapping periods. The practical application of telemetry to the study of small mammal population dynamics and to the ecological influences on behavior are discussed. The incorporation of telemetry into extensive studies of small mammals is recommended. (Financial support by the Theodore Roosevelt Memorial Fund of the American Museum of Natural History is acknowledged.)

## Subcellular Analysis Of Iguana Liver Cells; Isolation And Characterization Of Mitochondria

R. R. Ryel, G. B. Cline, and B. H. Levedhal  
Departments of Biology and Chemistry  
University of Alabama, Birmingham

The use of discontinuous density gradients permits a marked improvement in separation and purification of liver cell components as compared with continuous density gradients. It is possible with the discontinuous gradient to fractionate iguana liver cell homogenates into nine zones. These zones are composed both of isopycnic particles and/or particles still migrating under the centrifugation conditions. Recovered fractions were assayed for RNA, protein, cytochrome oxidase activity and catalase activity. From these assays, mitochondria and peroxisome distributions in the gradient were established and predictions as to the content of the other zones were made possible.

## Destruction Of Aflatoxin In Corn By Gamma Radiation

G. A. Sansing, N. D. Davis, and U. L. Diener  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

The effect of gamma radiation on aflatoxin present in corn of varying moisture contents was investigated. Aflatoxin assays were by fluorescent thin-layer



chromatography procedures. Gamma radiation of approximately two million Roentgens from a cobalt teletherapy machine did not affect aflatoxin levels in dry corn meal. Gamma radiation of approximately 100 million Roentgens from a cobalt-60 source reduced aflatoxin levels by 95% in corn meal containing 48% moisture by weight. Gamma radiation of approximately 50 million Roentgens reduced aflatoxin levels by 56% in whole corn kernels with 21% moisture. Aflatoxin destruction was probably indirect, via oxidation by peroxides produced in the irradiated water in the moist corn. The high levels of radiation required together with the small sample sizes treated, were such that destruction of aflatoxin in commercial quantities of corn is probably not feasible by this method.

### **Intestinal Parasitoses Affecting The Cofan Indians of Dureno, Ecuador**

Sandra G. Smith and Carl F. Dixon  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

Dureno is a small Cofan Indian village located on the Rio Aguarico in the tropical rainforests of eastern Ecuador. In the summer of 1968, fecal samples were collected from 29 of the 88 inhabitants. Results of qualitative analysis of the fecals for the presence of parasitic helminth ova revealed that 48% of those sampled were infected by *Ascaris lumbricoides*, 90% by *Necatur americanus*, and 86% by *Trichuris trichiura*. Three per cent of those sampled had no intestinal helminth infections, 14% had infections of one of the above species, 38% had infections of two of the above species, 45% had infections of all three.

Results of the quantitative analysis of the fecals for the presence of helminth ova indicated that the worm burdens of those sampled were directly related to the inhabitants' daily activity cycles which influence the frequency with which they come in contact with surfaces contaminated with *Ascaris lumbricoides* and *Trichuris trichiura* embryonated ova and with *Necatur americanus* infective larvae.

### **Gas And Thinlayer Chromatographic Identification Of Endrin**

Wendell L. Sowell  
Livingston University  
Livingston, Alabama

Since the beginning of time, there has been a continuous running struggle between man and insects, and will continue, no doubt, as long as a member of the human race endures. There are some who believe that man is dominant over insects, but let us recall that during the period of written history that the great wars were not decided by man on the battle fields, but by insects, as a consequence of insect-borne diseases. The great plagues of history were caused by insect-borne diseases. Insects on two different occasions arrested the construction of the Panama Canal. The project to eliminate loss caused by insect vectors of human diseases is a multi-million dollar enterprise. Due to the toxicity of endrin, one of the highly-chlorinated hydrocarbon insecticides, and the fact that the government permits no endrin residue on edible products or

food-stocks fed to marketable animals, there is need for sensitive methods for detection of endrin. The present investigation was designed to develop a simple, sensitive method for detection of endrin in the nanogram or picogram range.

A method was developed that can be used to detect endrin at the 5-10 picogram level. This method involves the use of a customerized 4'  $\times$  3/16" stainless steel column using sand as the solid support and silicone D.C. 200 for the liquid phase. The carrier gas was a mixture of 95% argon and 5% methane, at a gas flow rate of 30 ml per min. each for carrier and auxiliary gas. Temperatures were as follows: oven 205 C, column 205 C, detector 210 C, injection port 207 C. The detector was an electron capture unit. When a temperature above 200 C was applied, endrin produced two peaks, with the first peak being an aldehyde and the second or smaller peak being a ketone. The column was pretreated in an oven maintained at 225 C and with a nitrogen flow of 30 ml per min., for three weeks. After the column was placed in the gas chromatography, a large quantity of chlorinated insecticides was injected and later a few microliters of apple wax was injected.

The column was conditioned to produce endrin peaks in about three and one-half to four min. The shape of the peaks gives an indication of the ratio of aldehyde to ketone or the rate of isomerization of the endrin molecule.

### **Biology Of The Stunt Nematode, *Tylenchorhynchus* sp On Soybean Plants**

Guang-yeong Wen  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Direct microscopic observations of the parasitic activity of the stunt nematode, *Tylenchorhynchus* sp., on soybean seedlings were made in thin coverglass and plastic boxes containing 1.5% water agar. The nematodes extended and retracted stylets about once a second when they fed on root surfaces. After the stylet was extended into a root cell, injection of a secretion for 30 sec was seen and this was accompanied by a slow contraction rate of the median bulb. Then the bulb began to pulsate rapidly for 3-10 min., depending upon the feeding sites. Dark brown discolorations appeared in the tap and secondary roots of infected plants. The distinctive root-stunting effect appeared from microsections to result from inhibition of cell elongation in the most frequent feeding sites, a 0.5-2.0 mm zone behind the root tip. Male and female nematodes entered the roots as endoparasites, but they usually were ectoparasites with a vagrant mode of life. Duration of the life cycle from egg to egg was 25 days.

### **Participation Of The Anti-Thyroid Drug Thiouracil In Anabolic Reactions Leading To RNA Synthesis**

Mei Ying Wong and Raymond H. Lindsay  
Departments of Pharmacology and Medicine, University of  
Alabama Medical Center and Nuclear Medicine Service,  
Veterans Administration Hospital, Birmingham

The anti-thyroid drug 2-thiouracil (TU) is closely related structurally to uracil, a natural pyrimidine precursor of RNA. The participation of TU in the

anabolic pathways for uracil metabolism to RNA has been studied. The enzyme uridine phosphorylase, which converts uracil to uridine, was unable to utilize TU as a substrate but was inhibited competitively by TU and TU derivatives. Conversion of TU to thio-uridine was accomplished with thymidine phosphorylase an enzyme widely distributed in mammalian tissues. Anabolic conversion of thiouridine to thio-UMP was catalyzed by uridine kinase, the enzyme that converts uridine to UMP. Thio-UMP was identified on the basis of the nature of the enzyme reaction, UV absorption characteristics, co-chromatography with authentic thio-UMP, the ratio of thiouracil, ribose and phosphate, and action of 5'-nucleotidase. Conversion of thio-UMP to thio-UDP, but not to thio-UTP, appeared to be accomplished by a mixture of rat liver nucleoside monophosphokinase and nucleoside diphosphokinase. Radioactive thiouridine was also converted by rat liver slices to compounds which had chromatographic properties that appeared to correspond to thio-UMP, thio-UDP, thio-UTP, thio-UDP-glucose and thio-UDP-N-acetylglucosamine. Radioactivity was also found in the RNA fraction. Thus it appears that TU can not only be converted to the corresponding nucleotides but may be incorporated into the RNA molecule.

## Symposium

### New Vistas In Biomedical Education

#### A Cooperative Approach To Continuing Education In The Health Field (Abstract)

John M. Packard  
Director, Alabama Regional Medical Program

Continuing education is necessary for the physician and all the other members of the health care team because fifty percent of medical knowledge is outdated every five years by ever-expanding research. Although the responsibility to keep abreast in this field is an individual matter, not all members of the health care team read their journals or recent textbooks, and many find it difficult or impossible to get away to attend the seminars and courses which are being given in tremendous numbers each year.

Several studies have concluded that continuing medical education is best carried out in the community hospital because this is where the health team works daily and where education can occur close to home and close to the patients. With the advent of sophisticated standards of practice in community hospitals, there exists a nucleus of a competent faculty, often organized by a Director of Medical Education. The trustees, staff, and administration must recognize that community hospitals are now educational institutions whether or not a housestaff or medical students are present, and that any place where medical care is rendered must also be a place where learning occurs. The faculty of medical schools, nursing schools, and schools for the production of other health workers, must also insure that their graduates are motivated to be lifelong students.

Cooperation of hospitals within a community permits better continuing education by minimizing the weaker aspects of some hospitals and utilizing the stronger aspects, while avoiding duplication. The hospitals in the larger cities can likewise serve as resource centers for the smaller peripheral hospitals. Ed-

educational programs are best overseen by a board composed of physicians, hospital administrators, hospital trustees, and concerned laymen; the benefits from frequent meetings of such a group extend beyond the field of education into many areas of health care.

## The Role Of Educational Technology In Biomedical Education

John Sharry

College of Dental Medicine

Medical University of South Carolina, Charleston

Educational technology does not necessarily consist only of the latest inventions such as computers and television tubes. It is in fact, a vast array of adjuncts used by the teacher when his presence alone would not suffice. Books and papers and periodicals are part of educational technology, as are microforms of the latter and blackboards, charts, photographs, slides and movies, audio and video tapes, models and exhibits; and so is computer related instruction. All of these things are extensions and amplifications of the teacher.

Books and papers and blackboards have been around for so many years that they are often overlooked. Few if any organizations would consider building an educational institution without a library or new classrooms without blackboards. Similarly, charts such as the periodic chart and large photographs and maps are essential to the conduct of so many classes that they are automatically included in planning. In technological education, slides and movies, models and exhibits have long been part and parcel of the learning process. Audio and video tapes have come more and more into use, and within recent years the fascinating potential of computer related instruction has made many of us long to afford them.

All of them have benefits; and of course all of them have disadvantages. The benefits are not always obvious to all teachers. Educational technologists are sometimes tempted to react against the common resistance to the use of new technology by exaggerating the capacities of the machines. Often, administrations genuinely interested in seeking improvement in teaching will prefer to support a small pilot project designed to demonstrate effectiveness. In this particular activity, a 'pilot' designed to show the advantage of educational technology but done with spare equipment and sparse financing often will prove the opposite to the casual observer. Dr. James Lieberman, who directs the Audiovisual Center of the National Library of Medicine in Atlanta has told me that it is almost antithetical to the goal to start out with small pilot audiovisual projects. Good audiovisuals cost money and they should be set up initially with proper funding, good tools, good people, et cetera. This does not say that the mere assignment of monies will mean that the task is well done. The good people are extremely important; perhaps more so in many ways than good equipment. But all cost money. Lucky indeed is that organization which finds a reasonably salaried dilettante who just happens to become another Cecil B. DeMille. So let us look sensibly at the limitations of these devices before we begin, for most of us are aware of the main advantages.

Books, papers and periodicals, for example, have the great advantage of making available the thoughts of one man to a multitude of readers. They have advantage also in the fact that we can scan them easily, flipping about the pages, seeking out the relevant sections noted to us by key word or headlines which every orderly writer uses. In technological fields, there is no doubt



that books and papers are limited in their illustrations. No matter how many pictures or prints in a book, each one is in fact a single still picture and the reader must put them together mentally into a flowing operational sequence. This is done so much better, of course, by cinefilms. Furthermore, the storage problem of books and papers eventually becomes considerable. Every library today is facing the problem of bulk storage for its books and periodicals. The projection for the need of such storage space in the coming years is staggering.

Microforms such as microfilm and microfiche are inordinately better from that point of view. It is obvious that the storage of microfilm is an infinitesimal part of the storage problem for books and papers, but presently, microforms are not used widely in libraries because of the ineffective devices used to read them. The smaller the reproduction size of a page, the more difficult it is to find a good reader available. For example, reading 35mm size newspaper pages in the public library is a comfortable thing, but reading microfiche where the page reproduction is on the order of perhaps an 8mm frame size will require a much better quality reader. In addition, microfilm rolls are difficult, but not impossible to scan. Microfiche is, of course, much easier to scan.

The lowly blackboard, so useful to so many teachers for so many years, has a built in problem of its own. It has little storage space and storage from one day to the next will depend largely on the whim of the janitor. Large photographs, charts and maps are very fine aids for small audiences but everyone who has ever sat in a freshman chemistry hall of two hundred students and tried to see the periodic chart, inevitably tacked up someplace in the front of the room, is aware of the limitations which such devices have. Slides have a great capacity to illustrate both pictorially and in terms of charts, graphs and tables, etc. The latter must, however, be used wisely. Only just so much information in table form should be put on a chart. It obviously makes little sense to project a slide of the periodic chart which is precisely the same size and contains all the same information that the periodic chart described just above contains. No one will be able to read it.

Movies, which are very expensive, are probably the best kind of audio-visuals to use for technological education today. A well made movie in color will obviously never take the place of a surgery residency but can do a great deal to teach a student some of the fundamental principles of surgery before he is ever allowed in the operating room to observe first hand. Besides the great cost of movies, they share with tape an essential defect, insofar as it is difficult to scan them effectively.

Audio and video tapes have a great deal to offer in educational technology. It is obvious that audio tapes can convey inflection of voice and meaning which the written word cannot. Presently the manufacturers have standardized on one size audio tape. This is not true of video tapes which have a variety of forms and formats, one of which is not directly playable on another instrument. In addition, of course, color on video tapes and television color in general still leaves a great deal to be desired, despite all the encouragement we have gotten from users and manufacturers. (I must admit, perhaps because of my own taste, I have not seen consistently maintained and correct color in any system anywhere. Time and time again I have been disappointed by color which has been represented to me as the finest "technicolor" representation of life.)

Models and exhibits cost money and both generally are a storage problem but serve their purposes amazingly well.

At last, we come to computer assisted instruction. Isn't it grand when a

student sits down at a typewriter keyboard with perhaps a light pen available to him to react with a screen which will, at the command of the computer give him directions, correct him gently, tell him he is not thinking and all in the politest fashion. It will allow him to progress at his own rate of speed through courses which are suitable for this type of format. I am presently convinced that most *advanced courses* should not be taught by computers for quite a long time. But in many technological courses, the use of computer assisted instruction would be a great advantage indeed.

It would free students from the imprisonment of the calendar. The student who enters medical or dental school in September of 1969 knows that he cannot graduate before May or June of 1973, regardless of how brilliant he may be. If, by the use of educational technology, we can release this calendar restraint from him, we will have made great strides in our educational process, enabling us to educate a larger number of health workers in any period of time than we are presently able to do. In addition, the slower student, by virtue of constant repetition will be able to complete in a stronger fashion the course work which he now must rush through in order to meet calendar deadlines. The drawback, of course, to computer assisted instruction is that the costs are presently tremendous and it is difficult to hire programmers who, in combination with faculty, would be able to program the instruments. It must be remembered that these instruments are incredibly stupid and perform their apparently marvelous tasks only because of the marvelous minds of men. Having said something now about the types of technology and the specific advantages and disadvantages we may ask next: What then are the reasons for using them? What are the general benefits?

First, they extend the teachers' influence. In this day, when teachers are not encouraged as are researchers, individuals who, almost in spite of the system, wish to teach and try hard to teach, should be nurtured and their influence extended as far as it can possibly be. Educational technological aids should be used to make available this teacher's thoughts not only to the institution in which he works but to other institutions in the world. Second, educational technology allows for repetition as wished where the student can keep going over material until, in his own time and fashion, he has secured it to his knowledge. This will allow for individual progress of the students who proceed bored through their education, never reaching their intellectual potential because they are impatient to move on and are prevented because of the system.

If good teachers are few, all teachers seem to improve when they participate in the activities of educational technology. It is, for example, very chastening to see one's lecture, which one thought was so good, played back on television tape. It is always a revelation to know how many "ahs" and "ohs" and stumbles, needless repetitions and poor gestures one includes in an average lecture. These may possibly go unattended in a live lecture, but in fact their deletion cannot but improve the quality of the lecture. It has been shown time and time again that those teachers who use movies and television and who look at their own slides so assiduously made and yet so unreadable, tend to become better teachers because of it.

There are general disadvantages to educational technology. In most cases, it is expensive and it is complicated. Its use requires attitudinal changes on the part of the faculty and as pointed out above, if done as a sort of demonstration project it is too often poor and thus may kill interest among faculty for a considerable period of time. Tradition very often tends to use new tech-



nology to record old methods for teaching. For example, there is little sense to taping the every day lecture of the every day teacher in the every day university. (It is obvious of course that when the Nobel prize laureate comes to lecture at your university, it should, by all means, be preserved on tape.) But television should be used for specific and illuminatory purposes. It is excellent for fine technological procedures which a whole class cannot see from their position at the back of the room.

It is almost inevitable that one or another university will polarize its efforts in education technology around certain types of technology which either are easily available to them or comfortable for them. In such cases, all students are subjected similarly and indiscriminately to the particular technology although all students do not react the same to any one method. It has been shown, for example, that certain students do much better with a book than they do with audiovisuals. They are bored with the latter and stimulated by the former. Conversely, other students, who find wading through a book to be a torture, pick right up with intense interest when a good audiovisual form is presented to them.

With this background, there are some relatively general and simple steps which one should employ in the use of all educational technological devices. In the first place, one should know what the objectives are in the educational process. It is certainly backwards to say "we now have television and fit all teaching into the television format." Not at all; just backwards! Instead, one should say, "we want to teach biochemistry to the students and these are the elements of the field which we believe the student should know before being adjudged capable of practicing or performing their biomedical task; then look to see which educational technological aides will properly fulfill those objectives." I am quite sure that certain courses may be well taught with nothing more than a blackboard and a *stimulating* professor in front of the room. Such a stimulating professor may find himself grossly impaired by the use of a variety of "gadgets" which annoy him.

Once the objectives of the course are known, there are variety of reservoirs of expert opinion both in journals and books and also in the person of competent consultants where one can get advice. Consultants are particularly useful, insofar as they can ascertain the particular circumstances of your institution and then offer advice concerning the usefulness of the various tools. These consultants should be aware of all kinds of educational technologists and should not be factory representatives for a particular product. Lastly, use common sense. Common sense that asks what is it, how does it work, who will use it, how much will it cost and, most important of all, will it really improve our educational system or is it a *fashionable thing to do*. We must not allow educational technology to eliminate face to face teaching in the university regardless of what courses we are teaching. Educational technology should never be more than an aid to a skillful teacher. Our first object should be always to acquire and encourage those teachers and extend their influence whenever and wherever we can.

And never try to force the use of these new machines and concepts on unwilling faculty. Rather, look for eager faculty or try to get indifferent faculty interested.

Technology is no longer an option, it is quickly becoming essential to the education of our youth.

## The Role Of The Undergraduate College In Preprofessional Training

Paul C. Bailey

Department of Biology

Birmingham-Southern College, Birmingham, Alabama

The remarks which I have prepared for this program are intended to be brief. They will not offer a formula or a suggested sequence of courses whereby an undergraduate curriculum can assure the student that he is ready to cope with the problems that he will face after the successful completion of his undergraduate program. These remarks will attempt to raise some questions that will hopefully suggest to us a need for some critical thinking and soul searching about our undergraduate curriculum. I am going to suggest that we begin to break away from our traditional methods of teaching, that we use a different approach with our students, especially in laboratory situations.

The undergraduate college has a difficult role. Not only is it charged with the responsibility of providing the pre-professional training adequate to get a student into a professional school and insure that he will be successful, but it also has the responsibility of giving the student the kinds of experience that will enable him to think for himself and to make his own value judgements. Yes, the role of getting him started on the road to becoming a citizen of his community and the world in which he lives. In preparing these remarks, I attempted to list some specific objectives for the undergraduate curriculum if it is to fulfill its responsibilities, but I became discouraged with myself. My list sounded like all of the others that I have seen many times before — a list of high sounding phrases that mean nothing in terms of what the undergraduate curriculum really accomplishes or what it should accomplish.

If we can keep one objective in mind as we plan our undergraduate curriculum and as we teach our individual courses, I think the undergraduate program might have a chance at being successful. If we can teach students the techniques of learning on their own, we will have made a contribution to their education that will insure them of success in their professional life as well as in their social and spiritual lives. The time has come when we can no longer teach all of the facts that are pertinent to any one area. In the first place these so called facts are continually changing. Some of what we teach today may be wrong tomorrow. Of course, there are some fundamental facts — truths that are not likely to change. I would suggest that we employ these kinds of facts to teach the student to learn on his own. Above all, we must point out to the student that all of the answers to all of the problems are not yet known and that what we do know about some areas is subject to change. Too many of us are guilty of leaving the impression that all is known already about the areas discussed in our courses. In my opinion this is one of the unpardonable academic sins.

An example or two will perhaps indicate the problems which we in the undergraduate colleges face, and no doubt a problem also faced by the professional programs. If we could test a student the first day he arrives on our campus as a freshman for the total number of facts which he knows, and convert this number into a percentage of the total body of knowledge known to man, and then do this at the end of his senior year, we would find that he has lost ground. In other words he knows proportionately less when he finishes as a senior than when he came to us as a freshman. In connection with this

same idea, someone has calculated that scientific journals are now being printed at the rate of 67,000 words per minute. These facts, and there are many more, are frightening. We simply cannot rely upon the teaching of factual information any longer except that which is essential to the teaching of concepts and ideas and those essential to the teaching of the learning process.

I believe the time has come when we at the undergraduate level must select certain concepts and principles that we think essential to an undergraduate curriculum and teach about these ideas. The selection of these concepts and ideas will of course be difficult and our list would probably vary from individual to individual, but perhaps the primary criterion in making the selection should be their appropriateness in terms of how well they show the student how he can learn on his own. We may be able to hold on to our traditional approaches in lecture if we will be honest with students and point out some of the unsolved problems relating to the areas that are under discussion. When we go into the laboratory however, I think that we should place a great deal of emphasis upon problem solving. We have heard a lot about this in the past few years but I don't know of many courses in many institutions where this is actually done. We give them cookbook directions when they go into a laboratory, we expect them to follow these directions, and we expect them to come out with a certain answer. Why not go into the laboratory and give the student a problem to solve, and with some guidance and direction from us, expect him to solve this problem? Why can't we require him to give some thought to organizing his approach to his own laboratory problems? Why do all problems have to be solved in the same way? Why not permit a student to use some of his own initiative? He might do a better job than we would do ourselves. Why not admit to him that there might be several directions in which he could go, and in each direction he might find a different answer to a different phase of the problem? I think this approach can be used even at the freshman level. Admittedly, it will take some time on our part as an instructor, but if we are to give the student his money's worth and give him something to take away with him at the end of four years, this is what we must do. In taking this approach to undergraduate education we will not only give the student some experience in thinking for himself, but we will also give him the experience of reading and writing. Much of the reading which we now require is aimed at memorizing enough facts to make a satisfactory grade on an examination, and much of the writing which we require is filling in the blanks on a quiz. These approaches do not teach students the techniques of communication.

I doubt that this problem which I am discussing is unique to the undergraduate program. No doubt the professional programs face the same problem. In fact it is probably more critical with them than with us. Yes, I think that the professional schools are going to have to use some of the same approaches in their curricula. They cannot possibly give the student all of the answers to all of the problems that he will face when he begins practicing his profession. In my opinion he will be far better off with fewer facts but with the ability to comprehend the material which he reads and to think through a problem by himself. This will enable him to come up with his own answer rather than having to turn to his notes or to his textbook. All of the answers to all of the problems that he will face cannot be found in his reference library after he leaves his professional school.

Most people will suggest that the problem solving approach to learning is slow and that it will take a good deal longer to accomplish this objective than

it does to accomplish what we are now doing. This may be true, but do we have to accomplish all that we think we are now accomplishing? An educated man, one that is genuinely interested in his profession and in his career, does not stop learning. He continues throughout his lifetime, and if we give him the tools and techniques whereby he can do this, he will most likely be successful in his profession. We have given him what he came for.

The role of the undergraduate college is becoming more and more difficult as a result of the pre-professional requirements imposed upon students who are applying to the various kinds of professional schools. These professional schools continue to add suggested courses to their list of entrance requirements. If many more of these requirements are added, the pre-professional curriculum will have to be extended in length, or else some of the undergraduate colleges who are honest about their purpose will simply have to say to the professional schools that we can not prepare students for your program during the four years allotted to us. I think the professional schools have a perfect right to prescribe what they want their students to have when they come to them as freshmen. I believe however, that they will eventually have to do this in some terms other than a list of specified courses, and that they will have to rely upon the honesty of the undergraduate college to certify that these students have met their entrance requirements, or else they will have to devise some sort of testing program that will answer this question for them. I do not believe that the undergraduate college can afford to abdicate its responsibility in the areas of the humanities, the social sciences, and the fine arts in order to give the pre-professional student the time which he needs to meet the requirements of the professional school if their list of required courses continues to grow. After all the undergraduate program is, as far as I know, the only one which assumes the role of preparing people in the non-professional areas. I am fully conscious of the fact that the scientifically oriented professional programs have stressed the idea of students getting a good background in English, Literature, History, Economics, Philosophy, The Fine Arts, etc. When they look with favor, however, upon the student who has had a year of calculus and a year of physical chemistry plus some of the advanced courses in biology at the expense of the non-science areas, I doubt that they are being realistic. One simply can not meet all of the prerequisites for the advanced science courses and at the same time get the experiences in the other areas that make for a well educated undergraduate. Somebody will have to make up their mind somewhere along the way about what they expect the pre-professional student to have when he applies for a particular professional school. The undergraduate college may then be able to better define its role in the pre-professional areas.

Perhaps I have strayed from my assignment in these remarks, but I feel very strongly that the role of the undergraduate college of today and of the future is not the teaching of large bodies of factual information simply because these facts are good to know. We must show students how to think and learn for themselves. If we can do this and at the same time teach them how to communicate, that is the art of reading and writing, we may have fulfilled our role.



## Symposium

### Some Experimental Approaches To Cancer Control The Role Of Biochemistry In A Cancer Chemotherapy Program: Mechanisms Of Action Of Some 6-Thiopurines (Abstract)

L. Lee Bennett, Jr.

Biochemical Research Department

Southern Research Institute, Birmingham, Alabama

6-mercaptapurine (6-MP) and some of its derivatives are useful anti-leukemic agents, and an understanding of their mechanisms of action is, therefore, both of basic and practical importance. 6-MP is not itself biologically active, but is converted intracellularly to the nucleotide (6-MP-RP). 6-MP-RP, the thio analog of inosinic acid, inhibits several of the enzymes involved in the biosynthesis of purine nucleotides; the most sensitive site in intact tumor cells is an early step of this pathway, apparently by a "pseudofeedback" mechanism. 6-MP-ribonucleoside (6-MP-R) is active only after its conversion back to 6-MP and therefore affords no chemotherapeutic advantage over 6-MP. 6-Methylthiopurine ribonucleoside (6-MeMP-R), however, is not cleaved to the free base, but is directly phosphorylated by adenosine kinase to the nucleotide, 6-MeMPRP. 6-MeMPR, in intact cells, is also a potent inhibitor of purine synthesis *de novo*. Studies in a number of types of tumor cells and host tissues show that 6-MeMPRP is a metabolite of 6-MP and is formed by the pathway: 6-MP  $\rightarrow$  6-MP-RP  $\rightarrow$  6-MeMP-RP. 6-Phosphoribosylpyrophosphate amidotransferase, the enzyme catalyzing the first step of purine biosynthesis and the site of normal feedback control, is inhibited by both 6-MP-RP and 6-MeMP-RP. The latter nucleotide is by far the most potent inhibitor and apparently is responsible for all or most of the effects of 6-MP on purine synthesis *de novo*. A combination of 6-MP and 6-MeMPR was potentiating against mouse leukemia and has also shown promise in the clinic.

### Experimental Drug Studies Using Cultured Leukemia Cells

Jo Ann Sneed, Elizabeth Ann Dulmage and Lee J. Wilkoff

Cell Biology Division

Southern Research Institute, Birmingham, Alabama

A basic concept in cancer chemotherapy is that, to cure the disease, drug dosages must kill every leukemia cell without killing the host, regardless of the total number of cells, their anatomic distribution, or metabolic heterogeneity. The effect of a chemotherapeutic agent on the kinetic behavior of dividing leukemia L1210 cells in culture may be indicative of certain properties of the agent. For instance, only cells which are in the process of synthesizing deoxyribonucleic acid (DNA) will be sensitive to certain drugs which produce a lethal cellular lesion by interfering with some aspect of the synthetic sequence involved in DNA synthesis. These agents are usually designated as cell-cycle-stage-specific drugs. On the other hand, certain agents produce lethal cellular lesions regardless of the physiological state of the cell and are considered to be nonspecific agents.

Proliferating cultured leukemia L1210 cells were exposed to effective concentrations of selected chemotherapeutic drugs for different periods of time,

and the number of cells surviving drug treatment was determined by animal bioassay. The number or fraction of cells surviving drug treatment was plotted as a function of the duration of drug exposure at each effective drug concentration.

When replicating L1210 populations were exposed to nitrogen mustard, 1,3-bis (2-chloroethyl)-1-nitrosourea, azaserine, and 5(or 4)-(dimethyltriazeno)-imidazole-4(or 5)-carboxamide, the kinetics of population reduction were first-order (that is, a constant fraction of cells were killed per unit of time). This type of kinetics indicates that these agents are probably nonspecific and that their effect was independent of the metabolic heterogeneity of the cell population. On the other hand, cell populations treated with amethopterin, 5-fluorouracil, 1- $\beta$ -D-arabinofuranosylcytosine • hydrochloride, vineristine, and colchicine were killed at a rate that deviated from first-order kinetics (that is, a constant fraction of cells were not killed per unit of time). These results indicate that these agents are probably cell-cycle-stage-specific agents and that the sensitivity of a cell population to such drugs depends, at least partly, on the metabolic heterogeneity of the cell population. Therefore, effective scheduling of drug dosages employing such agents should take into account the mean generation time of the particular cell population being treated.

## Mathematical Models As An Aid To Understanding Cancer Chemotherapy Data

Harris H. Lloyd  
Chemotherapy Research Department  
Southern Research Institute, Birmingham, Alabama

With the use of high-speed computers, mathematical models need not be limited to simple equations. The techniques of numerical analysis and the computational power of computers provide for the solution of mathematical models of almost unlimited intricacy. However, when mathematical models are to be applied to biological systems, their complexity is often limited by factors other than the versatility and power of digital computers. Biological data, in general, are much less precise than that which can be obtained from physical systems, and, therefore, the effect of minor variables may not be detected. When several different models can be constructed to account for biological observations, the simplest one is the one of choice unless there is compelling evidence otherwise.

The kinetics of cell kill for cultured L1210 leukemia cells when treated with various anticancer agents obey one of two rate laws — a first-order rate law or a rate law which can be described by a Gompertz equation. Both models imply a “mass action” effect, but the dependence of the Gompertz parameters on drug concentration is difficult to explain. A general mass action law also fits the data which is described well by a Gompertz equation. Deviation from first-order cell kill is usually associated with drugs which interfere with some specific function of the cell, i.e., DNA synthesis. Therefore, Takahashi's model (Theoret. Biol. 13:202-211, 1966) of the cell cycle was used in an attempt to explain the observed rate laws. The first-order rate law results under certain conditions, but the theoretical deviations from first-order kinetics are quite different from those observed.



## Experimental Cancer Chemotherapy With Rodent Leukemia

Joseph G. Mayo  
Cancer Screening Division  
Southern Research Institute, Birmingham, Alabama

Two basic approaches have been used in the cancer research program at Southern Research Institute.

Early work was primarily empirical in nature, in that we were searching among a vast multitude of synthetic chemicals, antibiotics, natural products, etc., for agents that would demonstrate selective toxicity for tumor cells as compared with vital body cells. The essential link for this approach was a predictive screen; i.e., an experimental model was needed that would have a high degree of predictive value for the human disease.

The most effective experimental screen in terms of correlation with clinical neoplastic diseases has turned out to be rodent tumors. With this system, selected mouse, rat, or hamster tumors are treated with potential anticancer agents. Those agents which demonstrate significant activity against a variety of rodent tumors are then selected for cancer chemotherapy in man. The majority of anticancer agents in clinical use today were selected through the rodent tumor screening system and this system is still being used.

Another important program at Southern Research Institute is built around those compounds which have demonstrated activity through the rodent screening program and in clinic. We attempt to improve individual activity by altering doses and schedules of compounds and by applying combination therapy with two or more compounds.

Evidence is presented which indicates that cell-cycle-nonspecific agents (alkylating agents, nitrosoureas and related compounds) are most effective when applied on a massive single-dose schedule. The cell-cycle-specific agents (antimetabolite drugs) appear to be most effective when given on a maximum exposure schedule.

Experimental results indicate that combination therapy using large single doses of CCNS agents followed by maximum exposure schedules with CCS agents is more effective than either drug applied alone at nontoxic doses.

## Comparative Metabolism Of Cytosine Arabinoside In Animals And Humans

L. B. Mellett  
Pharmacology and Toxicology Division  
Southern Research Institute, Birmingham, Alabama

In most animal species studied cytosine arabinoside (ara-C) is metabolized to uracil arabinoside (ara-U). The pyrimidine nucleoside deaminase responsible for this conversion has a unique distribution in tissues and animal species and represents the most important single factor in the regulation of serum levels of ara-C. The absorption, fate, and excretion of ara-C in animals and humans were studied by means of radioisotopic and microbiological methods. Serum half-lives of ara-C (50 mg/kg, i.p. or i.v.) in the dog, rat, mouse, hamster, and human were 95, 43, 37, 35, and 12 min., respectively. Ara-C could not be detected in monkey serum at any time period. The urinary excretion of ara-C in the dog, man, and monkey was 37, 6, and 0% of the dose, respectively. Ara-C required repeated administration for control and cure of L1210 leukemia

in BDF<sub>1</sub> mice. Exposure time and ara-C concentration requirements for effective L1210 cell-kill in tissue culture have been determined and it appears that these requirements hold for the *in vivo* control of L1210 leukemia in mice. A knowledge of these requirements and serum concentrations in animal model systems could guide us in the selection of dose and schedule for control of the human disease. (Supported by USPHS Contract PH43-65-654.)

## Response Of An Experimental Solid Tumor To Chemotherapy

Donald J. Dykes  
Chemotherapy Division  
Southern Research Institute, Birmingham, Alabama

Basic principles of solid tumor chemotherapy are obtained by studying the effects of anti-cancer agents on experimental tumor systems such as plasmacytoma in hamsters. Plasmacytoma responds unusually well to certain members of the alkylating agent class and cytoxan in particular. Due to this unusual response plasmacytoma has become a very useful tool in pointing out or clarifying trends noticed in other less responsive tumors. The objective of any cancer therapy regimen is to obtain a maximum tumor cell kill with a minimum of host toxicity in hopes of destroying every malignant cell without undue damage to the host. In planning chemotherapy of a tumor we must have basic information in regard to the tumor characteristics, the drug dose, the number of treatments and the proper interval between treatments. Experimentation with plasmacytoma has enabled us to predict the tumor cell population at the onset of treatment, the amount of cell kill after a single dose, the recovery time of the surviving cells and the host toxicity recovery time.

## Chemistry

### The Study Of The Reaction Of HCN And Chlorine In A Flow Reactor

W. S. Durrell and Robert J. Eckert, Jr.  
Geigy Chemical Corporation

It was necessary to determine the rate of reaction of  $\text{HCN} + \text{Cl}_2 \xrightarrow{\text{H}_2\text{O}} \text{CNCl} + \text{HCl}$  at varying acid and salt levels. Since previous laboratory trials indicated an extremely fast reaction, a flow system was utilized. Flow systems, in general, are discussed, and the particular system used in studying the homogeneous kinetics of the  $\text{HCN}/\text{Cl}_2$  reaction viewed.

## CSMP Applications To Chemical Problems

Clyde M. Haas  
Geigy Chemical Corporation

Analog simulation programs for digital systems have been in use for the past few years. The continuous system modeling program (CSMP) is a version of this general class for the IBM 1130 and IBM 360 computer systems. These

programs may be of real value to the chemist involved with solution of differential equations. Examples illustrated here include the, "particle in a box," problem employing the time independent Schrodinger equation a 2nd order differential equation. A first order series kinetics problem is also illustrated which involves the solution of a system of three first order differential equations.

## **A Normal Coordinate Treatment Of The Boron Trifluoride Dimethyl Ether Complex And Selected Deuterated Analogs**

Clyde M. Haas  
Geigy Chemical Corporation

Two spectral investigations of the boron trifluoride dimethyl ether complex have been published since 1962 and some disagreement in the spectral interpretation exists between these works. A normal coordinate treatment using the Wilson F and G method with a valency force field was undertaken in an attempt to find a reasonable force field for this molecule and to resolve the spectral interpretation.

Four analogs of the compound are fitted with 124 frequencies being included and a total of 34 force constants employed. The results between the observed and calculated frequencies are in general good but some discrepancies remain in the low lying frequencies.

## **Lithium Cleavages Of 12-Alkylbenzo[a]phenothiazines in Tetrahydrofuran. A Dealkylation-Desulfurization Reaction**

T. G. Jackson, S. R. Morris and B. W. Martin  
University of South Alabama, Mobile

A study of lithium cleavages of 12-methyl- and 12-ethylbenzo[a]phenothiazine in tetrahydrofuran is reported. A novel dealkylation-desulfurization reaction was observed in the case of 12-methylbenzo[a]phenothiazine to yield benzo[a]carbazole while 12-ethylbenzo[a]phenothiazine gave a complex mixture from which no identifiable material was isolated. However, thin layer chromatography indicated that 12-ethylbenzo[a]phenothiazine had undergone the dealkylation-desulfurization reaction to a limited extent. Particle size of the lithium metal used appears to be critical in the cleavage reaction. No cleavage of the 12-alkylbenzo[a]phenothiazines was observed when lithium aluminum hydride or lithium aluminum hydride and lithium metal in tetrahydrofuran was employed.

## **Chemical Studies Relevant To The Biosynthesis Of Inositols**

Donald E. Kiely and Hewitt G. Fletcher, Jr.  
University of Alabama, Birmingham

*D*-xylo-Hexos-5-ulose (5-keto-D-glucose 6-phosphate) has been postulated as an intermediate in the biosynthesis of *myo*-inositol 1-phosphate from D-glucose 6-phosphate. The synthesis of the non-phosphorylated analogue of 1, i.e. 5-keto-D-glucose (2), will be described. On treatment with dilute alkali

2 readily undergoes an intramolecular aldol condensation to give *myo*-inose-2 (3). Gas chromatographic evidence indicated that dilute alkali also converts 2 in part into *myo*-inosose-3 (4). The cyclization of 2 to 3 closely resembles a step in a postulated biosynthesis of *myo*-inositol 1-phosphate from glucose 6-phosphate.

## Electron Spin Resonance Investigation Of An Oriented Fluoro-radical At 77°K

Lowell D. Kispert and J. Hugh McDowell  
University of Alabama  
University

Irradiated crystals of sodium perfluorosuccinate were previously found to contain free radicals with three nonequivalent fluorines, one  $\alpha$  and two  $\beta$  to the unpaired electron. The  $\beta$ -fluorines were recently found to exist in 2 conformations with a barrier to transition between the two conformations of 5-6 Kcal/mole. However the temperature dependence of the  $\alpha$ -fluorine splitting was left unexplained. It was argued that the structure about the  $\alpha$ -carbon might be an important parameter to consider. A measurement of the isotropic  $^{13}\text{C}$  splittings at 77°K and 300°K should indicate the structure that exists around the  $\alpha$ -carbon at these temperatures. The structure around the  $\alpha$ -carbon that was deduced from measurements at 300°K was found to be neither planar nor tetrahedral, but approximately 9-12° from the planar configuration. This supports the argument that the configuration about the  $\alpha$ -carbon may play an important role in the temperature dependence of the  $\alpha$ -fluorine splittings. Electron spin resonance lines from other radicals interfered with the  $^{13}\text{C}$  lines at 77°K, thus preventing a measurement or assignment of the structure at 77°K.

## The Uptake And Elimination Of Chromium And Zinc By The Eastern Oyster, *Crassostrea virginica*

Frederick C. Kopfler  
Gulf Coast Marine Health Sciences Laboratory  
Dauphin Island, Alabama

That oysters accumulate trace metals to concentrations far exceeding those in the surrounding water has long been established. This phenomenon is of public health importance since oysters can accumulate elements harmful to human health. Early investigations were usually restricted to zinc, copper, iron and manganese because of available analytical methods. The recent advent of atomic absorption spectrophotometry has enabled investigations to be extended to many other elements.

In one series of experiments, the uptake of chromium by oysters maintained in a flowing seawater system was studied. Chromium was chosen for investigation because it commonly exists in two valance states stable in aqueous solutions. Concentrated solutions of chromium as either Cr (III) or Cr (VI) were introduced into separate seawater systems to provide a concentration of 0.1 parts per million (ppm) chromium. Chromium (III) was introduced as

the nitrate salt and Cr (VI) as the chromate ion. Analysis of oyster tissues over a period of weeks indicated that both valence states of chromium were concentrated. However, chromium (III) was concentrated by the oysters to an order of magnitude approximately ten times that of chromium (VI). The precise reason for this ionic selectivity by the oyster remains obscure at the present.

In another series of experiments, oysters containing approximately 2000 ppm zinc were placed in the flowing seawater system to determine their elimination or depletion rate of this metal. Analysis of oyster tissues over a period of 14 weeks indicated no appreciable decrease in zinc content.

### Homoenolization In Camphor

James L. Lambert  
Spring Hill College  
Mobile, Alabama

Partial interconversions between camphor (*I*) and the 6-*exo*-methyl and 6-*endo*-methyl isocamphanones (*III*, *IV*) were observed when the ketones were heated at 185° or 250° in *t*-butyl alcohol containing potassium *t*-butoxide. The homoenolate ion (*II*) is invoked to explain these interconversions. In this homoenolate ion negative charge generated by loss of a *beta*-proton to base is stabilized by homoconjugation, or orbital overlap between noncontiguous atoms, in which the negative charge is shared unequally between the *beta*-carbons and the oxygen. When camphor was subjected to homoenolizing conditions in deuterio solvent a deuterated camphor was obtained whose pmr spectrum indicated isotope exchange on the C.8 and C.10 methyls. This result indicates the existence of homoenolate species other than *II* in the camphor system.

### Methods For Chemical Analyses Of Alabama Estuarine Waters

Lloyd A. May and Heino Beckert  
Alabama Department of Conservation  
Seafoods Division  
Alabama Marine Resources Laboratory

As a cooperating agency with member states of the Gulf States Marine Fisheries Commission and the U.S. Bureau of Commercial Fisheries, the Alabama Department of Conservation's Seafoods Division took part in a Gulf of Mexico Estuary Inventory. Part of the hydrology phase of the inventory consisted of measuring total phosphorus, orthophosphates, nitrites, nitrates, dissolved oxygen, salinity, water temperature, pH, and turbidity in Alabama estuaries. Dissolved oxygen, salinity, water temperature, and pH were determined with portable meters. Turbidity was determined by the Hach method. The following procedures were used in determining the four micronutrients: for total phosphorus, the method of Harvey (1948); for orthophosphate, a modification of the stannous chloride method; for nitrite, a modification of the sulphanilamide method of Strickland and Parsons (1965); and for nitrate, the copper-cadmium reduction method of Wood, Armstrong, and Richards (1967). (This study was partially financed by funds made available by the Commercial Fisheries Research and Development Act, PL-88-309, Project 2-34-R.)



## Mixed Hydride Reductions Of Epoxides

Joe McCrary  
University of Alabama  
University

The reductions of 1-phenyl-2-methylpropene oxide and benzyldenecyclopentane oxide with lithium aluminum hydride and a 1:4 molar mixture of lithium aluminum hydride and aluminum chloride (a mixed hydride) have been investigated. Reduction of 1-phenyl-2-methylpropene oxide with lithium aluminum hydride alone yields, as expected, 1-phenyl-2-methyl-2-propanol. Reduction of this epoxide with the 1:4 mixed hydride reagent yields 2-methyl-2-phenyl-1-propanol, a product resulting from phenyl migration in the course of reduction. Reduction of benzyldenecyclopentane oxide with lithium aluminum hydride alone yields, as expected, 1-benzyl-cyclopentanol. Reduction of this epoxide with the 1:4 mixed hydride reagent yields a mixture of 1-phenyl-cyclopentylcarbinol (a result of phenyl migration) and 2-phenylcyclohexanol (a result of a ring-enlarging alkyl migration.) These results are interpreted in terms of a mechanism in which the rearrangements in the reductions with the 1:4 mixed hydride reagent are concerted with epoxide ring opening.

## Reversible And Irreversible Reactions In Coulometric And Voltammetric Processes

W. R. Mountcastle, Jr.  
Department of Chemistry  
Auburn University, Auburn, Alabama

A typical reversible reaction  $\text{In}^{\circ}_{(\text{Hg})} \rightleftharpoons \text{In}^{+3}_{(\text{Aq})} + 3\text{e}^{-1}$  obeys the Nernst equation in a Controlled Potential Coulometric Determination (CPCD) at a stirred mercury electrode. The  $\text{Fe}^{+3}_{(\text{Aq})} \rightleftharpoons \text{Fe}^{+2}_{(\text{Aq})} + \text{e}^{-1}$  deviates slightly from the Nernst equation in a CPCD at a Boron Carbide electrode and gives a linear conc. *v.s.*  $I_d$  relationship in Boron Carbide Voltammetry.  $\text{U}_{(\text{VI})} \rightleftharpoons \text{U}_{(\text{IV})} + 2\text{e}^{-1}$ , an irreversible process, shows much larger deviation in CPCD at a Boron Carbide electrode but nevertheless a workable conc. *v.s.*  $I_d$  relationship exists in Boron Carbide Voltammetry.

## A Spectrophotometric Study Of The Fe (III) Complexes Of Certain Phenolic Analogs Of EDTA

James E. Norris and James E. James  
Geigy Chemical Corporation

Absorption maxima and molar absorptivities of Fe (III) complexes of ethylenediamine di-(o-hydroxyphenylacetic acid) and of some chloro- and methyl-substituted analogs are reported. Stability constants were developed for several of the complexes and were found to be pH dependent. Analytical methods for assay of the sexadentates are described.

## Experimental Fertilizer Compounds Of Phosphorus, Nitrogen, And Sulfur

R. C. Sheridan, J. F. McCullough, and Z. T. Wakefield  
Tennessee Valley Authority  
Muscle Shoals, Alabama

Several inorganic compounds containing phosphorus, nitrogen, and sulfur were prepared and investigated as potential fertilizers. Diammonium hydrogen thiophosphate, sodium diamidothiophosphate, diammonium monoamidothiophosphate, and thiophosphoryl triamide were good sources of phosphorus and nitrogen in pot tests. Pyrolysis of thiophosphoryl triamide gave condensation products whose fertilizer value decreased as the chain length of the polymer increased on condensation at higher temperature. Two new compounds, ammonium hexathiohypophosphate and ammonium tetrathiotriphosphate, were prepared and characterized. Paper chromatography was used as an analytical tool.

## Gel Filtration Of Small Molecules

Thomas St. Pierre and William P. Jencks  
University of Alabama  
Birmingham

The relative elution volumes of urea, phenol and a series of salts, including guanidine hydrochloride and tetramethylguanidine hydrochloride, from polyacrylamide and dextran gel columns have been determined. The elution positions reflect an interaction with the primary amide groups of the gel and, except for salts containing di- or trianions, are correlated with the strength of the interaction of the same compounds with acetyltetraglycine ethyl ester. The results provide further support for the hypothesis that these compounds affect the physical state of proteins by interactions with amide groups, but they shed no light on the question of whether this interaction represents a specific site binding or a less direct activity coefficient effect.

## Surface Tension In Aqueous Solutions Of A Homologous Series Of alpha-Amino Acids

C. L. Woodley and Alan Hisey  
University of Alabama, University

The surface tension in aqueous solution of a homologous series of alpha-amino acids, from glycine to alpha-amino-n-octanoic acid, was investigated by the capillary rise method to determine if a relationship exists between concentration or chain length and surface activity. Glycine and alanine raised the surface tension in a manner similar to inorganic electrolytes. Homoalanine decreased surface tension logarithmically with increase in concentration like the fatty acids. When the attached alkyl group is n-propyl, or longer, the decrease in surface tension is linearly related to concentration and is proportional to chain length. Apparently the stable structural configurations of glycine and alanine shield the hydrophobic group from the solvent, enhancing the electrolyte effect of the glycyl and alanyl zwitter ions. When the alkyl moiety is larger than a methyl group the shielding effect is apparently insignificant, with the

hydrophobic group inducing an increase in surface activity. The apparent linear depression of surface tension by norvaline and the longer chained amino acids may be the initial, nearly linear, portion of a logarithmic slope whose extension is experimentally prohibited by the limited solubility of these compounds.

## Geology

### Sedimentary History Of A Middle Oligocene Valley— In Northwestern Nebraska

Herbert S. Chaffin, Jr.  
Geological Survey of Alabama

In Sioux and Dawes Counties, Nebraska, near the base of the Pine Ridge Escarpment, an ancient valley is exposed in the outcrop of the basal portion of the Middle Orella Member of the Brule Formation of the White River Group of Oligocene age. The valley is known as the Toadstool Park paleovalley and is divided into upland and channel-complex facies. The upland facies is characterized by red mudstones representing soil zones formed during periods of non-deposition. The channel-complex is characterized by a gray, cross-stratified sandstone, overlain by light green and orange mudstones.

The valley was formed by the down-cutting action of an eastward-flowing stream and later filled by sediments deposited by the same stream. The sandstones of the channel-complex facies were deposited as the stream meandered in the valley, and the mudstones of this facies were deposited during periods of flooding. The mudstones of the upland facies are a product of the soil-forming process and occasional major flooding of the nearby stream.

The sequence of valley forming and filling is common in the Oligocene, Miocene and Pliocene sediments along the Pine Ridge Escarpment in western Nebraska and western South Dakota. (Publication authorized by the State Geologist.)

## Forestry, Geography And Conservation

### Suspended Particulates In The Air Of Some Alabama Cities— Compared To Criteria Published By The U.S. Department Of Health, Education, And Welfare

James W. Cooper  
Alabama Department of Public Health

The U.S. Department of Health, Education, and Welfare has published criteria giving levels of certain air pollutants at which these pollutants are considered to have a deleterious effect on man and his environment. One of the published documents states that adverse health effects on human beings have been noted when the annual mean level of suspended particulate matter in the air exceeds 80  $\mu\text{g}$  per cubic meter. Air pollution levels in a given area are a function of population density, meteorology, topography, type of industry, and other less obvious factors; therefore air quality is not the same for all

people even within a small community. Data obtained from fixed, city-center sampling stations indicate that the 80  $\mu\text{g}$  per cubic meter level is being exceeded in many communities in Alabama.

## **The Problem Of A Greater Somalia**

Berkeley Hackett  
University of Alabama  
University

The Somali are a Nomadic people who occupy the Horn area of Africa. Their history goes back to sometime around the thirteenth century when the Arabs established trading interests along the East African Coast. Later the Portuguese, Italians, English, and French found their way into this region. By the turn of the present century the Somali homeland was controlled by Italy, France, England and Ethiopia.

The Somali people remained distributed among these various peoples until the end of world war II when Britain, having defeated Italy who had previously defeated Ethiopia, found herself in virtual control of the whole area. Finding themselves in the position of controlling power on the African Horn, the British, working through and by direction of the United Nations, began a plan to create an independent Somali nation. The Somali territory controlled by Britain was made into two trusteeships; one under Italian oversight and the other under British. These two trustee territories became independent in 1960. Shortly after independence these two territories joined to become the Somali Republic.

There has been a movement, beginning before formal independence to unite all Somali people into one nation. This would involve peoples and territory now belonging to Ethiopia, Kenya, and French Somaliland. This movement has grown in strength in the years since independence and has resulted at times in considerable bloodshed especially in the Ogaden area of Ethiopia and the Northern Frontier District of Kenya. Presently there is an uneasy peace, but the movement for a greater Somali is by no means dead.

## **A Preliminary Report On Air Pollution And Related Weather Conditions In The Tuscaloosa Area**

H. D. Hays  
Department of Geology and Geography  
University of Alabama, University

During the spring semester of 1968 in a geography field methods course it was suggested that the students might do an air pollution survey in the Tuscaloosa metropolitan area as one of the course projects. A map of known or suspected pollution sources was constructed which showed that the heavy industrial concentration along the Warrior River contributed a substantial amount of particulate and gaseous pollution. A standard high volume air pollution sampling machine was obtained from the State Health Department and samples were taken at 15 selected locations over a two month period. The material collected was extracted and a chemical analysis made of the pollutants. Weather data was recorded for each location while the machine was in use in order to relate changing atmospheric conditions to the amount of particulate matter collected each 24 hr period. A public opinion poll was also taken to determine

the opinions of the Tuscaloosa population concerning air pollution in relation to health, property damage, sources of the pollution and place of employment of the family breadwinner. Industrial opinions were also taken in relation to air pollution and conditions.

The following conclusions were reached upon the completion of the original 60 day study:

(1) Particulate pollution varied from 55  $\mu\text{g}$  to 165  $\mu\text{g}$  per cubic meter of air in the Tuscaloosa metropolitan area. The average for the 60 day period placed Tuscaloosa slightly above average for U.S. cities of 100,000 population with similar industrial development.

(2) The river valley and adjacent uplands within a mile of the valley edge had twice as many ground fog-smog mornings as areas two miles or more from the valley edge.

(3) The location of heaviest concentration (later substantiated by a summer project) had noticeably more precipitation than any other location. This was even more pronounced during the summer thundershower season.

(4) Low pressure conditions seemed to produce the highest concentration of particulate pollution, as well as gaseous pollution. Immediately following heavy rainfall there would be a brief period of low concentration which would usually begin increasing within 24 hr.

(5) The study was continued during the summer of 1968 and is being carried on through 1968-69 in order to give us a long term evaluation of air pollution in relation to weather conditions in the Tuscaloosa region.

## Political Geography Of Urban Areas: The Problem Of The Fragmented Metropolis In Alabama

Walter F. Koch  
Department of Geology and Geography  
University of Alabama, University

Political geography deals with the delimitation of the earth into political regions. Man's settlement habits have created regions small in area and high in population density. These regions have been given a variety of names derived from the Latin "urbanus" or the Greek "polis." Other terms such as, city, town and municipality have legal implication. A metropolis is an urbanized region with several municipalities clustered around a central city. Alabama has several such metropolitan areas.

Jurisdictional fragmentation and political competition for resources in a metropolitan area inhibit the kind of long-range planning and decision-making essential to effective local government. Various remedies have been proposed to alleviate the problems resulting from fragmentation of local government in an urbanized area. Remedies include (1) annexation of smaller towns by the central city, (2) creation of a city-county "Metro" council or federation, (3) voluntary cooperation among functional units of local government, and (4) establishment of Councils of Area Governments.

A review of the history of the various remedies and a study of the political climate of selected metropolitan counties suggests that the remedy most effective for Alabama is the development of positive regionalism through the Councils of Area Government.



## **The Basic Geography Curriculum In Alabama's Junior Colleges**

Walter F. Koch  
Department of Geology and Geography  
University of Alabama, University

Junior colleges are becoming an integral part of the Alabama network of higher education. The role of the junior colleges is many faceted. One role is to substitute for the freshman and sophomore years of a four-year university degree program. As such, the junior colleges must try to parallel the offerings of the universities.

Geography is an increasingly important subject in the universities of Alabama. The subject is required for many programs, especially in teacher training and it satisfies in part the general degree requirements in most schools. Since most general and specific degree requirements must be satisfied during the first two years of a university program, the responsibility for providing proper courses is shared by the junior colleges.

The state junior colleges are authorized to offer four courses as a basic geography curriculum: Principles of Physical Geography, World Geography, Geography of Anglo-America, and Economic Geography. Only a few of the junior colleges offer all four courses. Some offer only one or two. The primary reason for failure to offer the complete basic program is lack of trained geography faculty.

The dilemma facing geographic education in Alabama can in part be resolved by training more teachers in the subject. An increasing number of students have their career programs shaped in the junior colleges. These institutions can help alleviate the teacher shortage by offering a full program in regional geography, utilizing the social science staff available, and encouraging entering students to consider geography as a teaching or professional career field.

## **Prescribed Burning In Longleaf Forests**

William R. Maple  
Southern Forest Experiment Station  
USDA Forest Service, Brewton, Alabama

Longleaf pine forests are burned to prepare seedbeds and planting sites, control undesirable vegetation, improve grazing conditions, increase game-food production, control brown-spot needle blight, and reduce the amount of fuel available for wildfires. Despite considerable research, the long-term effects on the forest community have not been fully explored.

## **Some Agricultural Land Use Patterns In Taiwan Since 1945**

Bertis N. Rodgers  
University of Alabama  
University

Since the retrocession of Taiwan to the Republic of China in 1945, the population has increased from 6,090,000 to 12,454,302 in 1965, with a population density at this time of 890 persons per square mile. The total land area amounts to 13,884 square miles, approximately one-third the size of the state

of Virginia. The cultivated area amounts to only 24.5% of the total land area. With more than half of the adult population engaged in agriculture, the farms are very small with an average size of 3.5 acres. In spite of the limited crop land, high density of population coupled with a high birth rate, the Taiwanese farmers have been able to meet the increasing local demand for food crops as well as to produce agricultural products for export in considerable quantities. Since 1945, total agricultural production has increased by more than 100%, and average farm family incomes increased by 309%.

A limitation of natural resources, availability and efficient use of U.S. Economic Aid funds, governmental planning and policies favorable to agriculture, an intelligent and resourceful agricultural population, and growth of the industrial sector of the economy were factors influencing Taiwan's impressive record in agriculture.

## Mobile Home Industry Of Northwest Alabama

Merle Sherman  
Florence State University  
Florence, Alabama

The mobile home industry started nine years ago at Haleyville, Alabama and now has grown to some 20 plants, mainly in Franklin, Marion, and Winston counties. Almost 3000 people are employed in the plants and auxiliary industries are growing with the additional plants. The industry started in Indiana and Michigan but the greatest demand for homes is now in the southeastern states. Because of this, the industry has been growing rapidly in Florida, Georgia, the Carolinas and Alabama.

A reservoir of underemployed labor in an area where farming was never too profitable attracted the first plant to Haleyville. Since then other plants staffed by men who learned management and labor skills by employment in the industry have been built. The growth of the industry has been assured by the increasing demand for mobile homes which has resulted from the rising cost of single home construction and the increase in the formation of new households.

## Soil And Shifting Agriculture In Yucatan

Eugene M. Wilson  
Department of Geology and Geography  
University of Alabama, University

Yucatan is a karst peninsula of low relief in the tropics, covered mostly with dense secondary scrub forest. The noncommercial economy is subsistence shifting agriculture which formerly supported the highest level of lowland tropical culture ever attained.

The soils are residual from limestone weathering and appear to vary mainly according to the character of the parent material and the amount of rainfall. The most important soils are the red, Canuco or Kankab, and the black, or Acalehe. The red soils have been sometimes classed as laterites because of their color and possibly a degree of laterization. A more accurate classification might be Terra Rossa (Alfisol order). The black soils resemble the mid-latitude Rendzinas (Mollisol order).

Because of increasing rainfall from the northwest to the southeast, soils become deeper toward the central portion of the peninsula. Farmers who are

able, select land for maize in the deeper black soils, some walking 25 miles to the milpas. The black soils are considered more desirable for maize because they do not attract weeds to the degree that red soils do and are easier to clear; they are probably more productive as well. The red soils are used for other vegetable crops. In northern Yucatan, fields are planted for two years then allowed to revert to forest for 10 to 20 years.

Recent investigations showed that it was possible, with the agricultural system still in use, to support the high cultural level of the Maya Classic Period.

## **Physics And Mathematics**

### **New Tables For Application Of Group Theory To Lattice Spectra Of Crystals**

R. P. Bauman  
University of Alabama  
Birmingham

Development of laser Raman spectroscopy has provided an important new tool for studying lattice modes and other low-energy states in crystals. Detailed polarization measurements assist in the assignment of observed bands but this requires an analysis of the crystal symmetry, employing group theory, that can be time consuming. New tables now have been prepared, in conjunction with Porto and Rousseau, which permit extraction of the necessary information on lattice modes with minimum time and effort. The table can be applied to "internal," or "molecular," modes as well as to the translatory and rotatory modes of molecular crystals. The tables will be published.

### **Frequency Dependence Of Integrated Intensity In EPR And UPR**

Charles M. Bowden  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

A theoretical calculation giving the dependency of the integrated absorption on the resonance frequency is presented. For the effective intrinsic spin  $S \cong 1$ , a basic difference is noted between the case where the transitions are induced by photons and the case for phonon induced transitions. The theoretical predicted integrated intensity dependence for each of the two cases is given in terms of a power of the resonance frequency, i.e.,  $\nu^n$ . A simple example which considers transitions within a non-Kramers doublet is worked out as an illustrative example.

### **Hypersonic Flow Over Models In Rarefied Gasses**

W. J. Buck and R. F. Askew  
Physics Department  
Auburn University, Auburn, Alabama

The techniques of generating very high speed flows in a rarefied hydrogen atmosphere developed in research leading toward thermonuclear fusion are ap-

plied to a study of high mach number flows over standard aerodynamic models. The construction and operation of a plasma shock tube are described.

Photographs of the plasma flow of a mach 25 or greater wave over a  $10^\circ$  cone, a  $10^\circ$  wedge, and a pair of  $10^\circ$  wedges mounted side by side in the flow in hydrogen in the pressure range from 0.1 to 1.5 torr were obtained by the light produced directly by the plasma. The driving energy was varied up to 2,500 joules. A continuum flow shock structure was not observed.

## Computer Simulated Problems And Experiments In Physics Teaching

R. M. Brown  
Department of Physics  
University of Alabama, Huntsville

A preliminary report of an educational research and development project now in progress at the University of Alabama in Huntsville. A discussion of the concept of COMPUTER SIMULATION through a GRAPHICS DISPLAY TERMINAL by means of color slides of the first generation prototype console which the author has designed and built is presented. A brief discussion of the meaning of simulation and its advantages is reviewed. It is emphasized that the student has control of the experiment or problem in terms of standard *professional* instrumentation *not* in terms of computer concepts or hardware. The goals of the project are presented together with a description of the pilot course in which the initial phases of the project are being checked out. A list of experiments which are being performed in the pilot course is given and a specific example is discussed — mapping of electric fields from point, dipole, surface, and line sources, construction of the field lines and components, equipotential lines (in a plane), plotting of the motion of charged particles in the fields, and line integrals along student drawn paths. Future work and plans are mentioned briefly.

## The Seminar/Autolecture System

R. M. Brown  
Department of Physics  
University of Alabama, Huntsville

A model Seminar/Autolecture (S/A) is presented. The autolecture was prepared by A. I. Berman of Rensselaer Polytechnic Institute, Hartford Graduate Center, at the author's request who moderated the short lecture and seminar. A discussion of some of the current educational problems in traditional classroom lecture system, particularly lack of student involvement and overdependence of the student on the teacher, is presented together with the attempts to deal with them by such means as computer assisted instruction and video tape recording. The technical possibility of S/A is mentioned and some of its features are discussed — "S/A is an educational system low in cost and high in student involvement which combines new media and auto-instructional techniques" by combining in an essential way a high quality sound system using cassette tape recorders keyed to high quality, high contrast, color transparencies projected on a large screen. A discussion of the advantages of S/A follows together with facts concerning where the S/A system has

been used and the evaluation of its success as a teaching method. Preprints of an article entitled Experiences with Seminar/Autolecture by A. I. Berman and A. V. Baez are available from the author.

## Measurement Of Temperature Utilizing Photodiodes

R. D. Conard, C. R. McInnis, and R. F. Askew  
Physics Department  
Auburn University, Auburn, Alabama

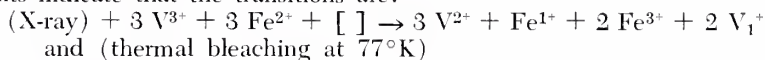
Temperature variations in a small tungsten plate are being investigated by a method that uses Wien's law to determine the temperature. Since a radiating blackbody emits a power maximum at a fixed wavelength independent of its geometry, measurement of this maximum allows one to calculate the temperature of the radiating body without consideration of its geometry. Using a lens and interference filter system, the temperatures of small areas of the surface are measured and combined to yield a picture of the variations in temperature across the plate.

## Photochromaticity In MgO

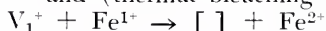
Army Daniel, Jr.  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

Electron paramagnetic resonance (EPR) and optical absorption have been used to measure transitions in MgO. Transitions were induced thermally with 50 Kev x-rays, and ultraviolet light. Changes were noted in the concentrations of  $\text{Fe}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{1+}$ ,  $\text{V}^{2+}$ , and  $\text{V}_1$  centers.

Concurrently, the crystals could undergo noticeable changes in the yellow and blue bands (yellow to clear, or blue to clear) depending on the initial conditions. The observed changes are very dependent upon the impurity concentration of the sample. In crystals with high Fe content, only the Fe was noted to undergo transitions. In low Fe content crystals, our crude measurements indicate that the transitions are:



and (thermal bleaching at 77°K)



These are consistent with our data.

## A Second Year Look At Student Centered Teaching

Army Daniel, Jr.  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

As pervasive an issue as the most appropriate means to educational change in both student development and institutional reform is rarely resolved in any particular aspect of program evaluation. The evaluative questions and settings just do not conform to the standards of proof of the experimental setting with its concomitant high degree of control over extraneous variables. Any single



set of evaluative data is confounded by a multiplicity of unresolved questions which potentially offer alternative explanations of the results. However, the assumptions behind the evaluative framework are also different from the experimental setting. What we are interested in is not any particular single difference and its relative level of significance but rather a series of proofs and trends which indicate general change across a variety of variables which over time will indicate that the program is, itself, developing and acting in concert with the desired educational outcomes.

This preliminary report on the evaluation of the first year of the Thirteen Colleges Curriculum Program indicates both the limitations of the data as suggested above, but also, and far more important, indicates proofs and trends which support both the notion of some accomplishment of program objectives and the correctness of the program's approach to this student and institution population. The results are preliminary, include only twelve of the thirteen colleges. (Lincoln University is not included in this preliminary analysis due to problems with post-test data), and are not yet completely broken down by college. In addition, this analysis is only concerned with the results of standardized tests, surveys, and inventories. A more detailed analysis is presently being conducted which will include differentiation of results by college and additional variables concerned with student attitude, teacher and program personnel opinion and attitude, and more in-depth estimates of relationship and causation.

Although the trends, which will be noted in the following data, are positive and in many cases statistically significant, these results are confounded by a variety of potential effects and conditions not met. Some of the more important potentially confounding effects would include: (1) change which might occur simply as the result of the college experience; (2) the general effect of aging or maturation; (3) the interaction between college and individual and local environment; (4) the interaction between a variety of other personality and ability factors; and (5) differential attrition between tested groups over time. It is also obvious that to a large degree the conditions of independence and homogeneity have not been met. The questions regarding independence are raised because the students are members of the college community at large with only a certain amount of their life-space associated with the program-treatment. The questions regarding homogeneity are raised by differences apparent between individual college programs and between differences potentially occurring between student populations due to the lack of random assignment. However, the fact that these two conditions have not been met adds even greater strength to the general results. The relative lack of independence and homogeneity generally creates interactions which tend to cancel out significant differences in results (which will be shown to have occurred in several instances).

## **Radiative Output From A Krypton Short-Arc**

S. K. Decker  
Physics Department  
Auburn University, Auburn, Alabama

Radiant output of high pressure, short-arcs in a krypton atmosphere has been investigated as a function of fill pressure, in the range 120-210 PSIA, and of input power, in the range 100-220 watts. The radiant output was measured

using a calibrated spectral integrating photocell, a modified Ebert spectrometer equipped with photomultiplier detectors, and narrow band interference filters coupled to photodiodes.

The output radiation was found to be nearly a linear function of the input power with the output in the continuum increasing at the expense of the line radiation as the input power increases. Further, radiant output was found to increase with increase in initial fill pressure. Small changes in geometry of the arc confining envelope were noted to produce marked effects on the radiant output.

## Relationship Between Turbulence And Wind Shear

Oskar M. Essenwanger  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

In modern analysis of turbulence the utilization of the power spectrum as an analysis tool is widespread. It has been proven by Kolmogorov (1941) and others that the slope of the power spectrum is usually  $-5/3$  for turbulent conditions. In recent years studies of clear air turbulence data have resulted in different numbers for this slope, ranging from  $-3$  down to  $-5/3$  with little explanation for these deviations. Physical interpretation is somewhat obscure, even if consideration is given that the power spectrum is a modified Fourier Analysis and that the energy of the wave components is obviously differently distributed for the various resulting slopes.

More clarity on this subject can be brought by analysis of the wind shear and the variation of the wind shear with the shear interval. The author together with Reiter (1969) has recently pointed out that a relationship between power spectrum and wind shear exists via the structure function introduced by Tatarski (1961).

The structure function  $D_{f(r)} = c^2 r^p$  (1)

has a corresponding spectral density function

$$V_{(k)} = \frac{\Gamma(p+1)}{2\pi} \sin \left\{ \frac{\pi p}{2} c^2 k^b \right\} \quad (2)$$

$$\text{where} \quad b = -(p+1) \quad (3)$$

represents the slope of the power spectrum.

The relationship between wind shear and shear interval (see Essenwanger 1963) can be expressed by

$$\overline{\Delta v} = \sqrt{D_{f(r)}} \quad (4)$$

and

$$a_0 (\Delta h)^{a_1} = c r^{\left\{ \frac{p}{2} \right\}} \quad (4a)$$

$$\text{with} \quad 2a_1 = p \quad (5)$$

This provides a tool to link turbulence and wind shear together and the exponent for the wind shear analysis can shed light on the structure of the turbulence for the range of the slopes in question.

An exponent of  $1/3$  with  $-5/3$  for  $b$  has been found by the author (1963) for mean extreme shears, which seem to correspond closest to the conditions of turbulence. A significant contribution to the interpretation of power spectrum structure is the result of another analysis. The author (1965) has split

the wind profile of instantaneous rocket measurements (Reisig 1956) into stationary and nonstationary parts. The stationary part rendered an exponent of  $a_1 = 0.8$ , while the nonstationary part as a true random collective with no vertical dependence resulted in  $a_1 = 0$ . This points out that turbulence with an exponent of  $1/3$  and hence a slope of  $-5/3$  displays a specific structure in the atmosphere leading to an energy relationship as expressed by Kolmogorov's findings. Deviations from his value indicate the presence of stationary wave phenomena, in which the balance of the wave components as compared with turbulence is modified. Dominance of large scale waves leads to coefficients of  $> 1/3$  with probably 1.0 as the boundary (linear progress) and the respective power spectrum slopes from  $-5/3$  to  $-3$ . The prevalence of short range (random) fluctuations may produce exponents between  $1/3$  and 0 and thus slopes between  $-5/3$  to  $-1.0$ . The latter corresponds to the "white noise" condition.

The above interpretation of the relationship between wind shear and turbulence is supported by the presence of clear air turbulence in mountain waves (Reiter 1966) and the exponent 0.5 for mean wind shears, which arises by superposition of stationary and nonstationary wind profile parts.

## A Solution To The Boltzman Equation In The Scattering Approximation

Howard J. Foster  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama  
and  
Department of Physics and Mathematics  
Alabama A&M College, Huntsville

A solution of the Boltzman equation in the scattering approximation is obtained for the case of electron-impurity scattering in an impure bcc metal, in terms of parameters appropriate to potassium. The results are compared with theoretical predictions of the free electron model. The utility of this method is illustrated in the discussion of spherical Fermi surfaces which might appear to be smaller in diameter because of premature scattering of electrons by impurities.

## The Cooperative College-School Science Program

W. L. Furman  
Spring Hill College  
Spring Hill, Alabama

For five years the Alabama Academy of Science conducted a Cooperative College-School Science Program supported by a grant from the National Science Foundation. About 20 school systems were assisted each year in improvement in their mathematics and science courses. One result of the Academy program was a Cooperative College-School Science Project conducted by Spring Hill College in 1965-66 to assist Conecuh County in improvement of its mathematics curriculum. This effort was extended to Baldwin, Brewton and Wilcox School Systems during 1966-68 and will also include Mobile County and Jackson, George and Harrison Counties in Mississippi during 1969-70. Subject matter knowledge and presentation skills of mathematics teachers in the participating system have been improved. New cooperative projects in

Alabama during 1969-70 will be conducted by Florence State University to incorporate Elementary Science Study materials into the curriculum of the Tusculumbia School System and by Troy State University to assist school systems in southeast Alabama in improvement of their instructional programs in biology.

## The "Curious Optical Theorem" Of The Dihedral Mirror

Rudolf F. Glaser

Propulsion and Vehicle Engineering Laboratory  
George C. Marshall Space Flight Center, Alabama  
and

Herbert B. Holl

Physical Sciences Laboratory  
Redstone Arsenal, Alabama

In recent years, attention has been drawn to the unexpected behavior of a rotated dihedral mirror, which is an optical system consisting of two plane mirrors fixed at a given angle to each other. When the dihedral mirror is rotated while a ray of light emitted from a fixed source is being passed through the system, the position and direction of the twice reflected light remain constant. The name given to this physical statement is "curious optical theorem." Several papers (Samberg, Morris. 1967. *Am. J. Phys.* 35(9): 882; Givens, M. Parker. 1968. *Am. J. Phys.* 36(9): 851-853; Streib, John F. 1968. *Am. J. Phys.* 36(9): 853-854.) published in the last two years dealt only with a special case and presented a quite complicated mathematical theory to explain this behavior.

The simple explanation presented here is based on purely geometrical principles and is applicable generally to the dihedral mirror system. Also presented is a solution to the problems of the incident ray bundle oblique to the axis. The final result is a method of determining the configuration applicable to deflecting light in any direction.

In addition, proof is given that the rotation of the dihedral mirror does not produce a variation of the "geometrical path" from a given point P on the incident ray to a fixed point on the emergent ray produced by the two reflectors: the derivative ( $dL/d\theta$ ) of the path length with respect to the angle of rotation is identical to zero. However, the "optical path" length does vary with rotation of incidence on the two mirrors, because of the phase shift due to the reflection, which in turn depends on the angles of incidence of the mirrors. This fact is illustrated using gold mirrors and the light of a helium-neon laser ( $\lambda = 6328\text{\AA}$ ). Since energy will be absorbed with each reflection, the entire reflection loss is also discussed as a function of polarization and angle of incidence. Another fact noted that appears to be of special technical importance is that in some cases the reflection of the dihedral mirror has a higher reflectance than does the reflection of a single mirror.

Proposed applications of the dihedral mirror — reflectometer, intensity and phase modulator, ring laser gyroscope, laser resonator — are briefly discussed.

## Jupiter's Great Red Spot And Solar Activity

E. R. Graf  
Auburn University, Auburn, Alabama  
and  
C. E. Smith  
University of Mississippi, Oxford

For many years, considerable speculation has been associated with the markings of the giant planet, Jupiter. Particular interest has been given the Jovian so-called "Great Red Spot." Inasmuch as the Red Spot intensity and coloration as well as sun spot activity are functions of time, the thought occurred to see if a correlation between the two was discernible. A comparison of the two phenomena was made for a period from 1892 through 1947. The two activities were plotted on the same curve, and in our opinion a correlation does exist. However, whether this present opinion is correct or not remains to be seen. A careful mathematical analysis is now necessary to make a final decision.

## Production Of Microwave Energy Using Solid State Devices

C. E. Hanke, J. J. Hanlin, and R. F. Askew  
Physics Department  
Auburn University, Auburn, Alabama

Using commercially available tunnel diodes it is possible to extend the resistive cut-off frequency up to three times the classically accepted value. This development requires a new interpretation of the tunnel diode mounting and equivalent circuit. The diode used is a 1N3718 which is mounted in a modified RG-52/U waveguide. The waveguide mount has a built-in RF by-pass and a tapered waveguide section to reduce load impedance to the diode. With the diode mounted at the center of the waveguide, double frequency oscillation has been observed which is due to the highly frequency dependent waveguide parameters.

## Photochromaticity: Radiation Induced Color Change

R. L. Hartman  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

Recent developments of bistable optical devices have opened the door to optical data storage and processing. Phenomena storage densities are predicted for a new class of materials called photochromies. "Photochromic" means "colored by light" but the definition usually includes colored by electron beams, x-rays or heat. For example, one type of photochromic crystal turns red when red light shines upon it and turns blue when blue light shines upon it, forming a memory device. The effect can be explained in terms of promotion of the electrons to the conduction band in a system where at least two types of traps exists. In conjunction with laser light sources, storage capacity is currently on the order of  $10^6$  binary bits per  $\text{cm}^2$ , and can be expected to approach  $10^9$ , so a practical device could include approximately  $10^{11}$  bits on one crystal.



## **Preparation Of Cadmium Sulfide Thin Films By Vacuum Deposition**

Michael Hartwell  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama  
and

Alabama A and M College, Huntsville

A review is given of the theory of a piezoelectric thin film dielectric which is used to excite ultrasound waves in a crystal in the presence of a magnetic field at temperatures below liquid helium.

The advantages in the use of a thin film transducer deposited directly on a crystal substrate, over that of a quartz transducer, are emphasized with illustrations and comparisons of ultrasound attenuation curves. A straight forward method of producing a cadmium sulfide (CdS) thin film piezoelectric transducer in a vacuum by electron bombardment heating for controlled vaporization of CdS pellets is described, with emphasis on the experimental conditions for good reproducibility. The major difficulties with the thin film vaporization techniques are discussed.

## **Measurement Of The Lifetime Of The 14.4 KeV Level Of $\text{Fe}^{57}$**

Thomas G. Ladd and John R. Cooper  
Physics Department  
Auburn University, Auburn, Alabama

The lifetime of the 14.4 KeV energy level of  $\text{Fe}^{57}$  was measured. Times between the detection of 122 KeV gamma-rays, which are associated with the creation of 14.4 KeV states, and the detection of 14.4 KeV gamma-rays were measured with the restriction that the 14.4 KeV gamma-rays had to be detected within one microsecond after detection of the 122 KeV gamma ray. The number of such events was plotted against their time intervals. No statistical analysis of the data has yet been made, but a visual fit to the data points gave a half life for the 14.4 KeV level of  $98.1 \pm 1.4$  nanoseconds.

## **A Satellite Study Of Cyclonic Storms Over The Southern Ocean**

David W. Martin  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

Cyclones over the Southern Ocean have been investigated by means of conventional and Nimbus II satellite data. The analysis was divided into two sections: an eight day map series showing the movement of a long wave trough across the Australian sector of the Southern Ocean, and a detailed examination of four cyclones which developed in the trough.

It was found that among Southern Ocean cyclones there is great variety in genesis, movement, size, and intensity; hence, there are frequent departures from the classical wave cyclone model. Cyclones developed in three general patterns — as waves on a front, as crescent clouds triggering waves on a front, and as crescent clouds developing behind a front. Frontogenesis seemed to occur with cyclogenesis, and the fronts associated with a cyclone usually could be uniquely related to distinctive cloud patterns. It appeared that as the cy-

clones intensified their vortex clouds grew at a rate that produced an approximate doubling in size each day. Growth slowed or ceased as the cyclones began to weaken. Decay of the cyclones was indicated by increasing distortion of the vortex pattern and a general lowering of cloud tops. Indirect evidence suggests that pronounced middle level descent occurs between the arms of the vortex hook. No evidence was found to indicate that Southern Ocean cyclones differ in any fundamental sense from their counterparts over the northern Pacific and Atlantic Oceans.

## **Ultrasonic Electron Nuclear Double Resonance Technique**

H. C. Meyer, C. M. Bowden, and P. F. McDonald  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

We report a technique for performing the UPR analogue of the ENDOR (Feher, G. 1959. Phys. Rev. 114:1219) technique. In a conventional ultrasonic paramagnetic resonance (UPR) spectrometer the sample lies outside the cavity and, hence, it is easy to place it in a coil or another cavity to simultaneously propagate an ultrasonic wave and apply an rf field. In conventional EPR, the sample is inside the microwave cavity and an rf field can be applied to the sample in addition to the microwave field to do ENDOR experiments. However, because of the problem with the "skin effect" at nuclear resonant frequencies and the alteration of the cavity Q by introducing a conducting material about the sample, the application of the rf to the sample is relatively more difficult. Since there are some paramagnetic materials which have inhomogeneously broadened absorption lines due to hyperfine or superhyperfine interaction, and which also have strong UPR but relatively weak EPR absorption such as  $\text{CaF}_2:\text{U}^{4+}$  (Meyer, H. C., P. F. McDonald, J. D. Stettler, and P. L. Donoho. 1967. Phys. Letters 24A:569; Bowden, C. M., H. C. Meyer, P. F. McDonald, and J. D. Stettler. 1969. Superfine Interactions in the EPR and UPR Spectra of  $\text{CaF}_2:\text{U}^{4+}$ , accepted for pub. J. Chem. and Phys. Solids) the UPR nuclear double resonance technique, which we describe, can be quite useful in the study of these materials.

## **Some DWBA Polarization And Cross Section Calculations Of d, n Reaction On Light Nuclei**

T. G. Miller and F. P. Gibson  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

Recent measurements on the polarization of the neutrons from the d,n reaction on beryllium have shown a characteristic trend of direct reactions. Assuming a direct reaction mechanism, efforts have been made to obtain simultaneous fits to both polarization and cross section data. In general, it has been possible to obtain qualitative fits to either the cross section data or to the polarization data, but not to both simultaneously.

## Design And Construction Of A Long Counter

Robert D. Passmore and John W. Michel  
Physics Department  
Auburn University, Auburn, Alabama

A shielded long counter, using a  $\text{BF}_3$  detector, has been constructed for use with the Auburn University Dynamitron. Several improvements have been made in the counter which both maximize the sensitivity, and minimize the variation in sensitivity with variation in neutron energy. The counter and its shield were also designed so that actual construction would be as simple as possible. The efficiency of the counter, and its shield, were checked using a 100 millicurie  $^{241}\text{Am}$ - $^9\text{Be}$  source.

## A Computer Aid For Teaching Quantum Mechanics

Walter J. Rhein  
Spring Hill College  
Mobile, Alabama

A computer program for solving and graphing the Schrodinger equation for the radial functions of hydrogen was prepared, following suggestions made by H. M. Schey at the 1967 meeting of AAPT (Amer. J. Phys. 35:676 (1967)) and by R. M. Eisberg (Fundamentals of Modern Physics, Wiley, New York). Both well-behaved and ill-behaved wave functions can be plotted. Physically acceptable solutions are seen to depend critically on eigenvalues of angular momentum and of energy and on the quantum rule that  $l$  be less than  $n$ . The program has been used as a teaching aid in both physics and chemistry. Features of the program will be discussed and results produced on an IBM 1130 will be shown.

## Light Pulse Spectrum Of A Proportional Counter

E. L. Robinson  
Physics Department  
University of Alabama, Birmingham

Prompt short-duration ( $\approx 1\mu\text{-sec}$ ) pulses of light are observed to accompany the normal discharge of a Geiger tube. The shape and amplitude distribution of these pulses is shown. Further study of these pulses is under way as well as extension of the measurements to proportional counter pulse spectra.

## Introduction To Matrix Methods In Charged-Particle Optics

Donald L. Smith  
U.S. Army Missile Command  
Redstone Arsenal, Alabama

A brief introduction is given to the analytic techniques used in solving common problems in charged particle optics. It is shown that the formalism for the paraxial-ray or first-order approximation can be easily treated by matrix techniques. These methods afford great flexibility in design work. Matrices for common optical elements will be exhibited.

## Anode Current Distribution In A Hydrogen Discharge

H. W. Spencer, S. J. Marsh, and R. F. Askew  
Physics Department  
Auburn University, Auburn, Alabama

The electron current density on the anode surface has been studied for a hydrogen glow discharge for a low ( $<1$ ) length to radius ratio. The current density was studied by means of a segmented electrode divided into 20 concentric rings with every third ring divided into 60 degree sectors. The current density profile was found to depend on the pressure and the total current. The maximum in the current density was found to lie off the axis of symmetry of the discharge.

## Effects Of The 2-Year Cycle On Extreme Winds And Temperatures

Dorathy Anne Stewart  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

Several investigators have found a quasi-biennial cycle in meteorological data. However, except in the tropical stratosphere, this cycle has been demonstrated only for long-term running means. Data compiled by the Aerophysics Branch of the U.S. Army Missile Command indicate that extreme values are also affected by this oscillation of approximately two years. Our climatological information includes magnitudes and dates of the five maximum and five minimum temperatures at one-kilometer intervals from the surface to 25 kilometers for several stations in the Northern Hemisphere. Detailed data on wind extremes at Montgomery and Chateauroux will also be discussed.

## Photoconductivity In Magnesium Oxide

Hanno T. Tohver  
Physics Department  
University of Alabama, Birmingham

A proposed experiment to measure the radiative lifetime of the excited state of the F centre in MgO will be described. On the assumption that the decay scheme of the excited state closely resembles that of the F-centre in KCl, the radiative lifetime can be determined from the lifetime of the electrons thermally excited from the excited state to the conduction band. The detailed mechanism will be discussed and an outline of the experimental method will be presented.

## Cyclotron Resonance Method Of Measuring Effective Masses

Hanno T. Tohver  
Physics Department  
University of Alabama, Birmingham

The general principles of cyclotron resonance measurements of effective masses of free charge carriers in solids will be discussed. These will be illustrated with experimental results in indium antimonide. Two hole effective masses have been found—a light hole of effective mass  $m^* = (0.016 \pm 0.002)m_0$  and a heavy hole of mass  $m^* = 0.34 \pm 0.02 m_0$ . Both masses appear isotropic within the experimental error.

## Low Temperature Response Of Scintillators

A. H. Werkheiser and T. G. Miller  
U.S. Army Missile Command  
Redstone Arsenal, Alabama

The relative light output as a function of temperature for gamma-ray irradiation was measured for the following scintillators: stilbene, Pilot B, NaI(Tl), and CsI(Tl). The temperatures involved varied from room temperature to liquid nitrogen temperatures. Little change is observed for the organic scintillators while a considerable reduction in signal occurs for decreasing temperatures with the inorganic scintillators. Stilbene pulse shape discrimination capability to neutrons and gamma rays was observed for temperatures also varying from room temperature to liquid nitrogen temperatures. Little change was noticed.

## Zero Deviation Point Of A Prism

Wayne Yancey  
Physics Department  
Auburn University, Auburn, Alabama

A recent application of a right angle internal reflecting prism in a laser optical train required that light entering one face of the prism maintain a constant point of incidence on the hypotenuse face of the prism as the prism was rotated through small angles. The desired axis of rotation was about some point on a line normal to the hypotenuse face of the prism through the  $90^\circ$  apex angle of the prism. This report details the determination of the proper point on this line.

## Industry And Economics

### A Profile Of Industrial Aid Bond Financing In Alabama

Arthur A. Thompson  
Graduate School of Business  
University of Alabama, University

Early in Alabama's industry-recruiting campaign it became evident that special promotional efforts were required to make industry aware of locational advantages in Alabama. The State Legislature responded to this need by passing the Cater Act and the Wallace Act, both of which enabled localities to issue revenue bonds for the purpose of constructing industrial facilities for lease to private enterprises. In addition 28 special amendments to the State Constitution have been passed allowing all or certain specified municipalities in 22 counties to issue general obligation bonds for the same purpose.

From 1952 through 1968, there have been 308 reported issues of revenue and general obligation bonds to aid in expanding Alabama's manufacturing economy. Over 200 firms were aided: \$785,697,000 was invested in plant facilities; and 42,336 manufacturing jobs are estimated to have been directly provided by the plants so financed.

Without the firms and jobs secured with the help of these industrial aid bonds, the rate of Alabama's industrial expansion would undoubtedly have been slower. Although many of the firms which used such financing would



have located in Alabama anyway, an estimated 60 to 70 firms employing nearly 17,000 persons and having a combined annual payroll of \$100 million would have been lost to other States in the absence of industrial aid bond financing. Per capita incomes in Alabama are 1 to 2% higher because of the presence of these 60 to 70 firms (ignoring secondary effects). Furthermore, state and local tax revenues are between \$4 and \$5 million greater because of the \$100 million in income they provide to Alabamians.

The industry attracted with industrial aid bonds is now serving as a base from which to launch a sustained program of economic improvement. Community development has been accelerated and the length of time it will take Alabama to achieve income parity with the rest of the Nation has been substantially reduced.

### **Slave Operated Louisiana Sugar Plantations: A Profitability Study**

David O. Whitten  
Auburn University  
Auburn, Alabama

This study is an investigation of the profitability of sugar production in antebellum Louisiana. The purpose of the paper is the determination of the role of Louisiana sugar plantations in the southern staple-crop-and slave producing economy.

The general findings of the study which reflect the profitability of antebellum sugar plantations are as follows: (1) Sugar planters, supported at least partially by the tariff on foreign sugars, imported slave labor at least until 1840. (2) Rising slave prices and land values, and the growing capital costs of progressive sugar processing technology, together with cuts in the tariff in the mid 1840's, resulted in a decline of slave imports and perhaps sales of slave surpluses from the sugar area during the remaining antebellum years. (3) The protective tariff was not essential to the continuance of the cane sugar industry, but served to provide higher than normal profits for heavily capitalized planters, and a margin of profit for the others. (4) The majority of Louisiana sugar planters were marginal producers who entered the sugar industry in the early antebellum period when slave and land prices were low and sugar tariffs kept market prices high. (5) The fall in the level of the sugar tariff (1840's) affected expectations sufficiently to cause a secular decline in the number of sugar producers.

### **Science Education**

#### **The Junior High School Science Program: Its Status And Needs**

A. J. Atkins  
Department of Secondary Education  
Auburn University, Auburn, Alabama

From an historical viewpoint the junior high school general science program has evolved from numerous separate courses in the sciences into a two-

year sequence of study of life science, physical science, and earth science. The program is designed as one to make provision for general education — that is, a study of that science which everyone should know regardless of what one's life work is to be.

It is believed that the junior high school general science program occupies a position of significant importance in the secondary school program; one as important as that of any of the other sciences which are taught in the secondary school. It is unfortunate, however, that the resources which are devoted to this program in terms of physical space, teaching equipment, and teacher preparation do not belie this importance.

On the assumption that the junior high school general science program is not surpassed in importance by any other science instructional area in the secondary school, the following recommendations are made:

1. Teachers should be employed whose major responsibility is to work in the area of general science and duties to this area should take precedence over those to other areas.
2. The general science program in a school or school system should be placed under the coordinating responsibility of appropriately prepared personnel. Such personnel should have the responsibility for developing and administering the instructional program in this field of study.
3. In terms of physical arrangement and the existence of instructional equipment and materials, the junior high school science program should possess a home in the physical plant. A center for instruction needs to be located at a designated place with appropriate facilities.
4. The space, facilities, and equipment should equal those which exist in the senior high school for the teaching of biology, chemistry, and physics.
5. The faculty who work in this area should be provided with leadership and encouragement to develop a sequential program of study in general science, the results of which would take the form of a syllabus to be used as a curriculum outline or guide or instruction in general science in grades seven, eight, and/or nine.

## **The Effects Of The Use Of Self-Directed Learning Activities On Achievement And Retention Among College Students**

Neil Clark

Department of Secondary Education  
Auburn University, Auburn, Alabama

The major purpose of this study was to determine what differences, if any, existed in (1) achievement, and (2) retention among college students when taught with the use of self-directed learning activities as when taught the same material with the use of conventional procedures. The effects of self-directed learning activities on the achievement and retention of college students with varying abilities in science as well as the subjects' opinions concerning the use of self-directed learning activities were also assessed.

This study involved two sections of a class in general science for in-training teachers offered at Auburn University during the Fall quarter, 1968. Seventy-seven students participated in the study. Experimental and a control classes

were established. The STEP science test was used to determine individual levels of science ability. The experimental class was instructed using self-directed learning activities while the control class was instructed using conventional procedures. An achievement test was administered to determine individual levels of achievement and retention. An opinion questionnaire was administered to determine student reactions to the experimental procedures.

An analysis of covariance revealed that there were no significant differences in the achievement and retention of the two groups. An analysis of the opinion questionnaire revealed a net positive reaction by students toward the use of self-directed learning activities. On the basis of these analyses it was concluded that continued experimental use of self-directed learning activities in teaching college students was justified.

## **A Progress Report On Implementation Of IPS In Five Schools**

Hollis C. Fenn

Florence State University, Florence, Alabama

and

J. Edward Griffith

Central High School, Lauderdale County, Alabama

Five days of pre-service and ten days of in-service training were used to prepare 12 teachers in the Florence area to implement the new Introductory Physical Science (IPS) in five area schools. The program in three of the schools is described briefly using slides, and the one at Central High School is described in more detail.

In this school, the physical science course proposes that students gain both knowledge and some insight into the means by which knowledge is acquired. The central theme of this course is the introductory study of matter. The sequence of laboratory activities dealing with the properties of matter is so designed that upon them may be built a step-by-step development leading to an atomic model of matter.

The students at Central High use both class and study hall time. They meet lab three days a week and have pre and post-lab sessions two days a week where they can properly interpret experimental results. Each pupil performs and writes up experiments designating interpretations of purpose, procedure, data, conclusions, and explanation for basis of conclusion. Experiments in the following subject matter were performed: mass, volume, densities, thermal expansion, freezing and melting points, solubility and solvents, separation of substances, compounds and elements, radioactivity, atomic model of matter, atomic size and mass, molecular motion and heat. Four of the experiments are demonstrated in photographs.

The IPS Program has given meaningful lab experience to pupils who had never had lab work before. Improving techniques, scientific interpretation and evaluation, based on more complete understanding and logical scientific conclusions, have greatly increased their appreciation for science. This program can be used as a complete study, or supplementary program as needed.

## Preparing Teachers To Use ESS and SCIS Materials In A Team-Teaching—Individualized Instruction Program

Hollis C. Fenn  
Florence State University, Florence, Alabama  
Charles M. Weller

University of Illinois, Urbana, Illinois  
and

Brandon B. Sparkman  
Tuscumbia City Schools, Tuscumbia, Alabama

One of six groups in a two-week team-teaching — individualized instruction workshop at Tuscumbia City Schools was concerned with elementary science. This group investigated the feasibility of using ESS and SCIS materials in team-teaching and individualized instruction programs. The teachers had three sessions before the workshop began where they were given materials and with very little instruction were encouraged to explore or investigate various phenomena associated with these materials. In the beginning the teachers were quite skeptical of this approach.

During the summer workshop, the science group worked with 20 children of mixed abilities from several grade levels for about 1½ hr each day. The children were divided into small groups and each group worked with one or more of the ESS or SCIS units. All the children worked in a large room and the teachers could move from group to group to observe and work with the children.

Many of the sessions were recorded on video tape. Following the teaching sessions the teachers viewed these tapes and discussed them. During the morning session they performed the activities they had planned for the children to do during the afternoon sessions.

As the teachers watched the small groups of children work with these new programs, their skepticism began to evaporate and they began to make specific plans to implement the programs in their schools. At the present time the teachers on the science committee are using the new science units in their own classrooms, and other teachers are visiting their classrooms to observe.

Florence State University and Tuscumbia City Schools have an NSF grant for a Cooperative College-School Science Program to continue the implementation of these programs.

## Laboratory Experiment Concerning Polymer Solution Viscosity And Molecular Weight

Richard S. Johnson  
University of Alabama  
Birmingham

Although the topic of viscosity is mentioned in general chemistry and physical chemistry text books under the subject heading of properties of gases, little is said about the viscosity of liquids and solutions. A modern viscosity experiment is one involving the solutions of polymers. Admittedly, some laboratory books do describe such experiments, but the polymer-solvent systems chosen leave much to be desired. Ideally, the polymer should be readily available and the solvent should have a low evaporation rate. It has been found that polymerized 1-vinyl-2-pyrrolidinone (polyvinylpyrrolidone or PVP) and water serve as an excellent polymer-solvent system. With this system, the students

not only learn the relationship between polymer molecular weight and solution viscosity, but are also made aware that polymer solution viscosity measurements are widely used in industrial polymer production control laboratories.

## Science For All Children—Eighth Grade Non Readers

Elizabeth F. Martin  
University of South Alabama  
Mobile

There are many junior high school science students who are non-readers or who read far below the level of textbooks and other materials used in science courses. In many cases these students are exposed only to the same methods and materials used in teaching and testing boys and girls with average ability.

The primary purpose of this continuing study is to determine and develop effective methods and materials for teaching and evaluating students in junior high school science who read below their grade level. A further purpose is to provide more meaningful experiences by relating many of the materials to the everyday lives of the students.

The students involved in this study had been grouped according to grades in all the subject areas and scores on the California Test. The I.Q. scores ranged from 71 to 95. The teacher had a B.S. degree and had finished the requirements for certification the previous year. This was her first year in teaching. The oral testing was carried out by students from the University of South Alabama. This was a part of the laboratory experience in their methods and materials course.

The areas chosen for particular study were lessons on the phases of the moon and on the tides. The teacher used a model she had made from aluminum foil, a lamp, and a globe to demonstrate the phases of the moon. Discussion was encouraged. The next step involved the use of diagrams of the moon's orbit and its phases as they appear from earth. These were on transparencies. Finally the students were asked to draw diagrams of the phases of the moon and its orbit.

Methods and materials used in the lesson on the tides were very similar to those used in the lesson on the phases of the moon.

Oral testing was carried out on a limited experimental basis. The test questions were written by the teacher. The students' oral responses were taped. Students were given pencil and paper and encouraged to draw diagrams as needed in explaining their answers.

The initial part of this study seems to indicate that the teaching methods and materials used were effective to some extent. The students responded well in class. They were not able to explain the phases of the moon or the causes of the tides. However, they did seem to understand the simpler cause and effect relationships.

Several factors were recognized as limiting the validity of the test. All of those involved in writing and administering it agreed that the test itself had several weaknesses. Those who administered it had never given an oral test before. There was little time to establish rapport with the students and attempt to eliminate some of the "fear factor" involved.

More extensive use of models and pictures and more active involvement of students will be planned for future lessons. An effort will be made to improve the method of testing and to develop more valid and appropriate tests.



## Synergistics In Science Education

Ernest D. Riggsby  
Auburn University  
Auburn, Alabama

A pilot, media-oriented, experiment at Troy Junior High School has indicated significant results in a program involving a synergistic approach to the teaching of sixth grade science. The unit used was in aerospace science and was based upon the enrichment unit outlined in the currently adopted Course of Study (Alabama Course of Study, Volume V, Grades 1-6, 1965, pp. 182-183) for the State of Alabama and was presented on a multilevel, multimedia, and interdisciplinary basis. While the concept of synergistics has existed in engineering, medicine, and industry for a reasonably long period of time, its application to elementary education is innovative.

In the Troy Experiment, every element of the brief unit was generated on site, with the students assuming a major role in the creation and selection of the materials which were studied. The role played by the teacher was one of learning engineer as opposed to the more widely identified function. The elements of the more classical unit were to be found in the experimental unit but with greater emphasis upon the student's actual involvement in producing the materials which were used in the study.

Creative writing, art, model building, spelling, arithmetic, social studies, physical activities, and essentially every other activity usually found in a sixth grade classroom were present in the experimental unit. However, the students were sufficiently involved in the work of the unit so that they were not usually aware that the normally separated disciplines of social studies, science, language arts, and the other "subjects" were being studied. An obvious assumption was used: "It is not essential that students be signalled that it is now time for arithmetic, science, social studies, or whatever subject is next on the time schedule — and learning is probably more natural and less artificial when it arises from a need or desire rather than from the ringing of a bell or some more subtle schedule signal."

Both objective and subjective criteria were used to evaluate the effectiveness of the experiment. Despite the statistically significant data resulting, subjective yardsticks of increased quality of oral and written work were considered stronger arguments in favor of further testing of the synergistic approach.

With the increased availability of educational media and more substantial training and experience for teachers, it would appear that more synergistic units might be feasible, and that areas other than science might be used as the central topics for such study.

## Seek-It: The Systems Approach For Teacher Training In Science Methodology

William B. Shell  
Auburn University  
Auburn, Alabama

In the science division of the Department of Secondary Education at Auburn, we are teaching our science methods course as we think a self-directed course should be taught. We are attempting to conduct our teaching course

in science (SED 405K) along the lines of the systems approach — that is — we are having the students go through the process of developing individualized self-directed units self-directedly.

We asked ourselves the question “What kinds of learning experiences should our methods course in science provide for our in-training teachers?” — and we sat down and listed them. We felt an in-training teacher should be able to:

1. Organize content
2. Determine the learnable ideas in this content
3. Write these learnable ideas in terms of student performance or behavior
4. Organize the evaluation in terms of these objectives — including a means of diagnosing and prescribing for learning difficulties
5. Develop lessons on a multi-level, multi-media basis — complete with quest activities, self-evaluation, and recycling.
6. Play the role of a consultant, instead of a “teller.”

If a teacher could perform these tasks then we felt she would have a good start in developing an individualized program when she began teaching in the public schools.

We created a name for the unit of work that would be designed along the afore mentioned paradigm — the name is SEEK-IT — standing for Self-directed educational experiences *Kit*. The big challenge in this type of endeavor was to develop a Seek-It production guide that would direct an in-training teacher through all the activities that are considered germane to a Seek-It. This Seek-It production guide has been written and then revised several times — and at this point is considered to be more than adequate in causing teachers to construct self-directed units of work in science.

## Interim Testing With Programmed Material In College General Science

William B. Shell  
Auburn University  
Auburn, Alabama

This project sought to determine among college students enrolled in elementary and in secondary teacher education at Auburn University the effect of interim testing on immediate achievement and subsequent retention of material learned about atomic structure and bonding taught by the means of programmed instruction. Additional purposes were: (1) to evaluate the effect of interim testing on material learned by students of varying abilities in science, (2) to assess students' opinions concerning the use of programmed instruction and interim testing.

Research evidence of the value of programmed instruction and interim testing has accumulated in a variety of subject areas in recent years. However, few studies have attempted to achieve the purpose of this project which was to compare the learning of groups that was brought about by interim testing during the use of programmed materials.

The objectives of the project were to investigate the effect of interim testing on (1) immediate achievement, and (2) subsequent retention by teacher-education students who studied atomic structure and bonding taught by pro-

grammed instruction. These objectives were related to the following four categories: (a) the total sample (global sense), (b) high ability students, (c) average ability students, and (d) low ability students. Eight null hypotheses were stated to test the objectives at the .05 level of significance.

The research involved two intact classes (N-48) as assigned through university registration in the course "General Science for Teachers" (SED 473). An experimental group and a control group were chosen by random selection. Students in both the experimental and the control groups were also ability grouped into high, average and low categories based on the *STEP* science scores. There were 16 subjects each in the high ability, average ability, and low ability groups in both the experimental class and the control class.

Pretest, *Nelson-Denny Reading Test*, and *STEP* science scores were used for covariant adjustments to statistically equate both classes for comparison in the global sense. Only the first two tests were used to equate respective ability groups in order to compare them statistically. At the conclusion of the study the pretest was administered to each group as the posttest. Six weeks later the posttest was readministered to both groups as a retention test. Posttest and retention test achievement scores are the dependent variables in the research. Five interim tests were given the experimental group of 48 subjects during the study of the programmed text. Interim testing was the manipulated variable in the research project. An opinion questionnaire was administered to both the experimental and control groups at the completion of the program. A  $2 \times 3$  Analysis of Covariance, using the F test, was performed to determine the effect of interim testing on immediate achievement and subsequent retention of the experimental group as compared to the control group.

The findings were as follows: Subjects administered interim tests, when compared to the control groups — (1) made significantly higher scores on posttest ( $P < .01$ ) and retention test ( $P < .01$ ); (2) high ability students failed to achieve at the .05 level on posttest, but were significant at ( $P < .01$ ) on retention test; (3) average ability students made significantly higher scores on posttest ( $P < .05$ ), and retention test ( $P < .05$ ); low ability students made significantly higher scores on posttest ( $P < .05$ ), and retention test ( $P < .01$ ).

Student opinions of programmed instruction were: (1) most students planned to use programmed instruction in future teaching, (2) prefer certain course units be programmed, especially in mathematics and science, (3) liked best the self-pacing, and small steps, (4) disliked most the repetitious aspects and (5) those in the experimental group felt interim testing was frequent enough.

Implications for teacher education would include: (1) interim testing can be used to increase learning effectiveness among students enrolled in programmed or traditional courses or units in the university setting, (2) interim testing can be used to increase learning effectiveness among student groups of varying abilities.

Recommendations as a result of this experiment would include the following:

1. This type experiment should be replicated in a variety of subject-matter areas and on various maturity levels.
2. This type experiment should be conducted in conjunction with other teaching methodology, such as class discussion, to determine the possibility of increasing learning effectiveness.

3. This type experiment should be repeated using other factored variables such as personality characteristics and anxiety levels.

4. This type experiment should be replicated sequentially (longitudinal study) to determine the effectiveness of concept-attainment and concept-formulation.

5. This type of experiment may be used by innovative teachers to become involved in action or experimental research in order to better evaluate their teaching and to add to the growing body of research knowledge.

## **Social Sciences**

### **Persistent Republicanism In Jefferson County**

Lee N. Allen  
Samford University  
Birmingham, Alabama

During the 1930-1950 era, Jefferson County mustered about 13% of its vote for Republicans on a few occasions and as little as about 4% on others. But during the Eisenhower administration a strong Republican vote developed in the county. In the presidential elections of 1956, 1960, and 1964 Republicans carried the county, but only in 1964 did they also carry the state. In 1964 Republicans also won several other county races, including Representative of the Sixth Congressional District; the victor, John Buchanan, Jr., was re-elected in 1966 and 1968.

An analysis of the vote by district reveals that the Republican vote of the county is strongest among those in the upper socio-economic groups. It is weakest among the Negroes and organized labor. Republicans have been unable to make any headway against George C. Wallace and candidates closely identified with him. Even strongly Republican areas, like Mountain Brook and Vestavia Hills, gave Wallace their presidential votes in 1968.

### **Word Association As A Technique Of Attitude Assessment**

Donald W. Dixon  
Birmingham-Southern College  
Birmingham, Alabama

White attitudes toward Negroes and Negro attitudes toward whites were assessed by a word association technique devised for the purpose of controlling 'socially desirable' responses. Thirty-six sophomore students at a predominantly white college were tested with a conventional attitude questionnaire and then with the WORD ASSOCIATION ATTITUDE TEST regarding their attitudes toward Negroes. In the word association method, subjects were asked to write as many associations as they could in a specified length of time to each of 15 stimulus words which were assembled into a booklet. All of the stimulus words were neutral or irrelevant except the key or ethnic words, such as Negro.

The WAAT responses were evaluated in several ways in an exploratory attempt to establish the efficiency of the instrument. The findings indicated that the results of the WAAT were in better accord with students' overt behavior toward Negroes than were conventional attitude tests. A second sample

of 36 Negro students from a predominantly Negro college was taken in order to establish the validity of the WAAT. Results from this sample indicated that Negroes had negative attitudes toward whites and only slightly positive attitudes toward themselves. Important differences were also found between Negro and white attitudes toward the Negro, not only in strength and direction of responses, but also in the character of the responses themselves.

## Graphic Anthropometry In The Study Of Body-Build

Helen I. Douty  
Department of Consumer Affairs  
Auburn University, Auburn, Alabama

A conceptual framework within which the body-image, as the locus of the self, could be studied should make a significant contribution to study of the self. To simplify and abstract the essence of the body form and to view the physical person in relation to standards are essential before hypotheses concerning the meaning and importance of the body-image can be successfully tested. "Graphic Anthropometry," a sophisticated type of silhouette photography, promises to make such study more fruitful than past approaches. Empirically derived scales of "Body-Build" and "Posture," along with a "Physical Inventory," have made quantification of observations possible.

This method has been successfully applied in classes in clothing education and in research studies. In "Postural Norms and Variances as Related to Body-Image," self body-build ratings were significantly related to body-esteem and "Self-cathexis" ratings. Thus, satisfaction with one's body appears to be essential for satisfaction with the self. Self perception of posture was significantly different from judges' ratings of posture. A preceding departmental study did not reveal a significant relationship between self and judges' ratings of body-build, thus challenging the validity of the body-image.

If it can be demonstrated that the self-image is subject to clinical treatment relative to physical condition and appearance, as well as to clinical treatment by psychiatry or psychotherapy, then a new area of physical and mental rehabilitation with great implications for education may be opened.

## The States' Rights Party Of 1948: A Rump Convention

Delores Ann Hobbes  
Shades Valley High School  
Birmingham, Alabama

As a result of the inclusion of a strong civil rights plank in the platform and because of the nomination of Harry Truman for President by the National Democratic Party, the States' Rights Party met in Birmingham, Alabama, in July, 1948. The convention, controlled by a few men from Alabama and Mississippi, nominated Strom Thurmond and Fielding Wright for President and Vice President. An eight-point platform which advocated support for the Constitution, segregation, and a return of political power to the people was adopted. Thurmond and Wright campaigned against the Fair Employment Practices Act, the anti-lynch bill, and the anti-poll tax legislation. The party gained only 38 electoral votes — these coming from states where the States' Rights candidates were on the ballot as the official nominees of the state party.



## Cayetano Perez And The American Occupation Of Mobile

Jack D. L. Holmes  
University of Alabama  
Birmingham

On April 15, 1813, General James Wilkinson accepted the surrender of Fort Carlota de la Mobila from Captain Cayetano Pérez, thus ending the Spanish domination of Alabama which had begun when Bernardo de Gálvez captured Mobile from the British in 1780. Born in Cartagena, Spain, Pérez had enlisted in the local militia in 1793 and rose through the ranks in the regular army until October 3, 1805, when he was promoted to captain in the Louisiana Infantry Regiment. He had served with bravery in a campaign against the Kemper brothers near Mobile in 1810 and was considered apt for a promotion to command the Cuban post of Matanzas in 1812. Yet, six months later he surrendered the fort under his command without firing a shot.

Pérez had only two alternatives: to surrender or die with his men in the rubble of the fort. Wilkinson had seven companies of infantry and one of artillery plus almost 300 men under Colonel John Bowyer of the militia. In addition, the American attacking force had artillery, scaling ladders, and siege equipment, and Wilkinson was fully prepared to use them. The Americans had 14 transports and a number of gunboats. They intercepted a ship bearing provisions for the beleaguered Spanish garrison and sent the small Spanish garrison on Dauphin Island back to Pensacola.

Pérez had a dilapidated fort which needed thousands of dollars worth of repairs and was so weak, its cannon could not fire at the enemy without crashing through the parapets! 24-pound balls were available, but only 18-pound cannon. Most of the equipment was likewise of no use or in poor condition. With the Louisiana Infantry Regiment down to 35 men and 4 officers; supplemented by only 75 men and 2 officers from a picket of the Puebla Infantry Regiment and 9 artillerymen and an officer from the National Artillery Corps, Pérez's force could not have numbered 150 — thus he was outnumbered at least ten-to-one.

What really decided Pérez and his officers to surrender, however, was the lack of provisions. On the day of the surrender, they had only one day's rations remaining and, because of the American blockade, no chance of additional supplies. According to Spanish military law, the commander was required to call together his officers in a council of war and explain the situation to them. This Pérez did. The officers unanimously agreed with Pérez to surrender, thus disregarding the instructions of the Governor at Pensacola to die in glorious combat under the rubble of the fort.

Pérez and his officers were courtmartialed in a trial that lasted from 1813 until 1822, when Pérez and his officers were cleared of the charges. It was already too late. By the Adams-Onís Treaty of 1819 and 1821, all of West Florida was surrendered to the United States along with East Florida and the disputed Texas boundary. Pérez had already passed to his eternal reward and was beyond the calumny his contemporaries were so quick to heap on his already-sorrowful head. As Commander Lloyd Bucher, Pérez had preferred to save the lives of his men rather than "go down with the ship." And America had won a new territorial hold on the Gulf of Mexico in a period that presaged Manifest Destiny.

## **A Criminological Study Of The Function Of Anxiety As Related To Anomie In A Prison Population**

Kenneth W. Lemmon  
Department of Sociology  
University of Windsor, Windsor, Ontario

72 inmates of a military prison were tested in the areas of anomie and anxiety. Five sub-scales were used to determine the overt and covert anxiety scores. They were guilt proneness and depression, frustrative id pressure due to blocked needs, paranoid insecurity, ego strength, and integrated self-sentiment. The Pearson-Product Moment revealed a significant correlation between the concept of anomie and four of the anxiety components; covert and overt guilt proneness, overt frustrative id pressure, and overt paranoid insecurity. It was found that the anomic inmate did not have a relative state of normlessness as proposed by Durkheim. Rather, those who lack social integration have internalized societal values and norms but have not found a legitimate means of meeting their goal needs. This was especially evident in the fact that negative sanctions toward the prisoner caused neurotic levels of guilt and paranoia.

## **The Cotton Tax In Reconstruction**

Milton McPherson  
Troy State University  
Troy, Alabama

Traditional interpretations of Reconstruction as a conspiracy to make the South economically subservient to financial and commercial interests of the North (Northeast) have been strongly challenged during the past decade. One aspect of Presidential Reconstruction which has been ignored by revisionist historians is the cotton tax imposed by an act of Congress in July, 1866. The imposition of the tax at a time when the South, except for Tennessee, was unrepresented in the Congress, and the drawback equal to the amount of the tax allowed to domestic manufacturers on cotton goods exported, lends credence to the conspiracy theory and strongly influenced the Dunning school of Reconstruction historians.

During the war, internal taxes were imposed on a number of raw materials, including cotton. In early 1865, David A. Wells was appointed chairman of a committee to overhaul the cumbersome federal tax structure. In determining the fate of the wartime tax on cotton, Wells relied heavily on the advice of Edward Atkinson, of Brookline, Massachusetts, and other representatives of the New England cotton textile industry. They recommended strongly, before the committee and privately, a heavy tax on cotton with a drawback equal to the tax on cotton textiles that were exported. Such a scheme opened to them the possibility of achieving a virtual monopoly on the world textile market if American cotton was, indeed, still "king." Moreover, the South could be made to pay a part of the cost of the war to the Union and England could be made to pay for her transgressions during the war. An act of Congress of July 13, 1866, imposed a tax of three cents per pound on raw cotton and allowed a drawback of the same amount on cotton goods exported. The requirement that the tax be paid before the cotton could be moved from the revenue district in which it was grown worked a needless hardship on the producer.

The tax was repealed in February, 1868. The price of raw cotton had risen four times higher than prices for cotton textiles, largely because of speculation in cotton, and the tax was imposed in the expectation that cotton prices would remain abnormally high for several years after the war. In spite of the dislocations in the labor supply occasioned by emancipation and other problems cotton cultivation recovered rapidly after the war. As cotton prices fell to normal levels the tax became increasingly burdensome, amounting in some instances to one-fourth the value of the cotton. Repeal of the tax became necessary, lest the cotton crops of 1868 and later be curtailed, with dire consequences for our international balance of trade.

The federal cotton tax, which yielded \$68,000,000, was bitterly resented because it was largely absorbed by the planter, and because it fell on Unionist, Secessionist and freedman alike. Sixty years after its repeal efforts were still being made to secure a refund of the tax collected after the war. Such persistent efforts to secure a refund of the tax suggest that the tax merits its description by Professor E. Merton Coulter as "the most indefensible tax in American history."

## Engineering

### Missions To The Outer Planets, Jovian Moons, and Halley's Comet

J. L. Archer

The Boeing Company  
Huntsville, Alabama

The concept of planetary swingby missions and its applications to the unique "Grand Tour Missions" to the outer planets are presented. It is shown that the gravitational field of a large massive planet can be used to alter the heliocentric trajectory of a planet bound spacecraft, sufficiently enough to realize large changes in the Earth departure velocities, planet arrival velocities, and mission flight times. Examples are presented showing that Jupiter, used as the swingby planet, reduces both velocity and trip requirements for missions to the outer planets; and in particular, numerical results for the "Grand Tour Missions" are presented. It is shown that the swingby technique permits trip times to Neptune ranging from 8-12 years over the comparable 30 year Hohmann transfer, and trip times to Pluto ranging from 10-12 years over the comparable 47 year Hohmann transfer.

The mission referred to as the "Grand Tour Mission" usually means successive unpowered swingbys of Jupiter, Saturn, Uranus, and Neptune; however, splitting the spacecraft in two parts, prior to the Saturn encounter, will permit Saturn to swing one portion of the spacecraft towards Uranus and Neptune and the other portion towards Pluto, thus allowing a complete view of the outer planets.

The planetary arrangement for the Grand Tour Mission occurs periodically every 179 years. The next set of launch opportunities available for the Grand Tour Mission will begin in 1975 and end in 1981 with the Jupiter-Saturn 1981 alignment. The next set of launch opportunities will not reoccur until 2154 A.D.

Each launch opportunity has a set of unique properties which identify specific mission requirements and can be used for selecting mission objectives. For all launch opportunities, however, there are two classes of missions: An interior and exterior ring passage at Saturn. The earliest launch opportunities occur in

1975 and 1976. These opportunities have only marginal possibilities for both interior and exterior ring passages, with 1975 being most marginal, in that Jupiter will just be moving into a favorable position relative to Saturn. This will result in unpowered Jupiter swingby trajectories to Saturn that will require either Jupiter swingby passage through the surface of Jupiter or trajectories unacceptably close to Jupiter. Unfortunately, Saturn will not yet be in a favorable enough position to swing a spacecraft close to Uranus, if greater passage distances at Jupiter are employed. The 1977 launch opportunity is among the most favorable in that the Earth departure energies are relatively low; and for the exterior ring Saturn passage, the swingby passage distances at Jupiter will permit the opportunity to closely examine the large inner moons of Jupiter, e.g., Europa, Ganymede and Callisto. A Saturn interior ring passage, however, will require passage distances at Jupiter very near the Jupiter radiation belts at 3 Jupiter radii. The 1978 launch opportunity is also a favorable launch opportunity. Moderate Earth departure energies are required for an exterior ring passage at Saturn which in turn will require passage distances at Jupiter near the orbit of Jupiter's satellite Callisto. The interior ring passage of Saturn requires Jupiter passage distances to be near the orbit of the Satellite Europa; but the most favorable feature of the 1978 interior ring passage is the 8 year trip with moderate Earth departure energy requirements. The 1979 launch opportunity is less favorable than the previous opportunities. Jupiter will begin to catch up to Saturn so that low energy missions will require passage distances at Jupiter near 75 Jupiter radii for an exterior ring passage of Saturn. The interior passages at Saturn impose severe Earth departure energy requirements, and do not appear attractive enough for practical consideration. Also with the 75 Jupiter radii passages of Jupiter for the exterior passage mode, no opportunity will be available for close examinations of the Jupiters inner moons; however, this situation allows minimum perturbation effects on the trajectory flyby spacecraft due to the moons of Jupiter. On the other hand, if the total trip time is allowed to increase, examination of the outer moons of Jupiter is possible — namely, Jupiter VI, Jupiter VII, and Jupiter X. The 1980 opportunity is a marginal mission. An interior ring passage of Saturn would require impractically high Earth departure energy requirements. A short time (11.6 years) mission would require high Earth departure energy requirements and passage distances of 70 Jupiter radii at Jupiter. Earth departure energy reduction can only be realized at the expense of increased mission time and greater passage distance at Jupiter. On the other hand, for large enough passage distances at Jupiter, an outer moon rendezvous may be possible similar to those of the 1979 opportunity. Moreover it is possible to accomplish a close encounter to the asteroid Vesta at this time, therefore making the 1980 launch opportunity slightly more appealing as far as viewing objects in the solar system is concerned. Using these launch opportunities, a variety of alternate and alternative mission modes are presented, including a set of "Grand Tours of the Lunar Moons," and a possible rendezvous with Halley's comet.

### **A Computer Study Of Abel Inversion**

W. J. Ashton and K. M. Pell

Aesospace Engineering

Auburn University, Auburn, Alabama

The Abel Inversion technique is used to obtain the intensity of a light source as a function of radial distance from its center when the intensity pro-



file as a function of distance perpendicular to its central axis is given. One of the main problem areas in this technique is that of obtaining an expression from the raw data which may be analytically integrated. Three techniques were chosen for investigation in this paper. They were: a numerical technique, a Gaussian fit, and a least-squares polynomial fit. An error analysis and comparison of costs were also included.

## **Observations On The Behavior Of A Resonant Tube Partially Filled With A Liquid**

B. F. Barfield

Department of Mechanical Systems Engineering  
University of Alabama, University

The general object of this study was to investigate the phenomena associated with a tube partially filled with a liquid and subjected to a resonant acoustic field. The basic objective was to obtain a correlation which would predict the conditions under which liquid "curtains" form in a horizontal resonant tube containing a liquid. Such a correlation will be presented. In addition, a comparison of theoretical pressure distribution and measured pressures will be presented. It will be shown that solutions employing first order and first and second order inviscid acoustic theory all yield accurate pressure results while differing markedly in the prediction of velocity fields.

## **Engineering Thermal Stress Cracks In Small Circular Disks Of Graphite Materials**

A. E. Carden

University of Alabama  
University

A test method has been developed that allows a relative ranking of polyphase carbide - graphite ceramics in their resistance to thermal stress cracking. A small, thin, hollow, circular disk is mounted on a water cooled heat sink and exposed to a tubular graphite radiator. The radiator, mounted in a suitable chamber, can be heated to 2400 C by resistive heating. Part of the specimen and all of the heat sink is insulated from the heat source. The remainder of the specimen is exposed to the heat source as a fin-receptor. As the radiator temperature is increased the radial temperature drop across the specimen increases. When the radial temperature drop across the specimen reaches a critical value a crack initiates at the inner boundary. A limited amount of data are given to illustrate the test method. Thermal stress cracking of AUC graphite is used as a relative base of comparison of the behavior of other materials.

## **A 35 Gigahertz Upconverter**

S. Curran and E. R. Graf

Department of Electrical Engineering  
Auburn University, Auburn, Alabama

This paper presents a study of a 35 gigahertz upconverter. Apparently, the simplest means of building the upconverter is by mixing the 350 to 450 megahertz modulating signal with a 35 gigahertz carrier signal in a balanced



mixer and filtering the lower sideband with a high pass filter. However, this method is impractical because a filter cannot be constructed to separate the upper sideband from the relatively close lower sideband.

A more practical method of unconversion is mixing a 350 to 450 megahertz modulating frequency with a Z gigahertz carrier frequency in a balanced mixer and then filtering out the lower sideband with a high pass filter. The second stage of upconversion is then accomplished by mixing the resulting signal (2.35 to 2.45 gigahertz) in a balanced mixer with a 33 gigahertz signal and then again filtering with a high pass filter. The resulting signal is from 35.35 to 35.45 gigahertz.

## Electronic Scanning Of Circular Arrays

M. D. Fahey, E. R. Graf  
Department of Electrical Engineering  
Auburn University, Auburn, Alabama

In the present age of technology, quick and accurate transmission of information is of primary importance because a fast accumulation of data is required. During World War II, radar communication systems proved their value as a means of obtaining information quickly and accurately. Since the war, more sophisticated systems have evolved to the point that the mechanically scanned antenna systems have approached the limits of their capabilities in regard to high scan rates. The highest scan rate of a parabolic disk is ultimately determined by its physical size and the tolerances of the motors which drive the antenna. A method which can increase the scan rate of the antenna is to scan electronically instead of mechanically; this will increase the scan rate because the scan rate is not a function of the physical size but a function of the bandwidth of the antenna. A circular antenna array can be scanned electronically by proper current amplitude variations to each element of the array. This paper presents a study of the current amplitude variations necessary to produce the correct scan.

## Vibrations Of Stiffened Rectangular Plates Using A Separation Method

T. E. Falgout  
University of Alabama  
University

The transverse vibrations of stiffened rectangular plates with stiffeners running parallel to one edge are considered. The Separation Method used consists of separating the stiffeners from the plating and writing the governing equations for the plating and stiffeners individually. These governing equations are then combined into a single governing equation for the original stiffened plate.

This method accurately considers the rotatory inertia and concentration of mass of the stiffeners. When compared to the classical panel method the number of conditions to satisfy is reduced by  $2N$ , when  $N$  is the number of stiffeners and these conditions are the simplest possible, those of continuity.

An example stiffened plate typifying a section of a ships' deck is considered. A comparison of the results obtained in a normal mode analysis by the separation method and equivalent orthotropic plate theory is made. To facilitate the

use of this separation method to response problems the governing equation is shown to be self adjoint. The orthogonality relationships are subsequently expressed.

## The Effects Of Retained Condensed Phases Upon The Performance Of Solid Propellant Rocket Motors

Bernice K. Hodge  
Mechanical Systems Engineering Department  
University of Alabama, University

One phenomenon of interest (and concern) exhibited by spinning rocket motors is the retention of metal-metal oxide within the motor chamber. The deposition of this material can be viewed as a two-phase flow phenomena enhanced and driven by spin. Examples of mass retention are well documented in the literature. The retention of metal-metal oxide affects performance in three ways: (1) less mass is ejected from the motor, (2) the transport properties of the exhaust products are changed, and (3) the weight of the vehicle at motor burnout is higher.

A study of the performance degradation caused by retaining various percentages of the condensed phases of the combustion products was conducted using several different propellant formulations. The specific impulse ratio, the ratio of the impulse with the retained phases to the conventionally defined specific impulse, and the burnout velocity were used as the two parameters of comparison.

Results of this study indicate that for high retention of condensed phases, relatively low performance non-metallized propellants compare favorably with the exotic highly metallized formulations as well as fluorocarbon formulations.

## The Stability Of Fluid Conveying Tubes With Periodic Perturbations

G. R. Hopkins and J. L. Hill  
University of Alabama  
University

The dissertation treats the question of the stability of fluid conveying tubes. The governing equation of motion for a tube conveying a fluid with periodically varying flow is derived. The question of stability is answered by approximating the governing partial differential equations by making use of the Galerkin technique. Regions of stability and instability are established by determining the characteristic exponents of the solution vectors.

The system of differential equations studied is of the form:

$$\ddot{X} + \sum_{q=-h}^h e^{iqt} F_q \dot{X} + \sum_{q=-h}^h e^{iqt} G_q X = 0,$$

where  $X$ ,  $F$ , and  $G$  are finite matrices.

Following the method of Floquet, solutions were assumed as

$$X(t) = \sum_{n=-\infty}^{\infty} e^{(\lambda + in)t} C_n,$$

where the characteristic exponents  $\lambda$  determine the stability of the system of

differential equations. Using these, the system of differential equations was transformed into the matrix equation.

$$A(\lambda) \cdot C = 0,$$

where  $A(\lambda)$  is an infinite square matrix of block sub-matrices and  $C$  is a constant infinite column matrix of block sub-matrices. It follows that the values of  $\lambda$  that satisfy, determinant  $A(\lambda) = 0$ , are the characteristic exponents of the system.

Due to the presence of the coefficients  $F_n$  on the first derivatives, the infinite determinant of  $A(\lambda)$  is not of Hill's class. However, a proof of the absolute convergence is given. This property of the determinant of  $A(\lambda)$  makes it possible to express the determinant in closed form, and subsequently, to display the characteristic exponents implicitly in a single transcendental equation. From this highly transcendental equation the characteristic exponents, and therefore, the stability, may be determined numerically.

The stability of an elastic tube with simply supported ends was studied. Regions of stability and instability were evaluated numerically using a UNIVAC 1108 digital computer. The influence of fluid velocity, mass ratio of fluid to tube, tube rigidity, perturbation frequency, and perturbation amplitude on the stability are presented.

## Analytical Investigation Of The Coupling Between Two Feed Loops In A Single Cavity

P. Johnson, Jr. and E. R. Graf  
Department of Electrical Engineering  
Auburn University, Auburn, Alabama

This paper presents an analytical study of a 2 GHz square waveguide cavity which is excited in an end wall by means of a loop configuration. The feed is designed to excite the  $TE_{01}$  and  $TE_{10}$  modes with a  $90^\circ$  phase difference. This produces a circularly polarized composite wave in the guide.

The feed consists of two loops in space quadrature and an axial coupling stub. In order to analyze this loop configuration, the loops are treated as a near field antenna problem enclosed in a conducting rectangular box. An exact solution of such a problem by means of the method of images requires consideration of an infinite array of three dimensional images. However, a good approximation can be obtained by consideration of only the closest images. A computer program has been written which solves for the current distribution on the loops by considering only the nearby images. This program allows various important parameters such as frequency and coupling stub length to be varied. Curves of the relative amplitude and phase of the  $TE_{10}$  and  $TE_{01}$  modes that would be excited are obtained as a function of these parameters.

## A Neglected Technique In Design

H. Kuenzel  
University of Alabama  
University

Number syntheses, the determination of the number of links and joints needed to accomplish a given motion requirement are beginning to have a

renaissance in the field of mechanical design due largely to the efforts of Kurt Hain in Germany and F. R. Erskine Crossley in this country.

The primitive designer is faced with many choices not the least of which is to choose from among many possibilities the optimum configuration of metal parts taking into consideration movability, friction adjustability, installation, maintenance, force distribution, or even just originality because of patent considerations.

Methods are shown for surveying the whole field of possible mechanisms from which the designer can choose the basic machine for purposes of his further elaboration. Illustrative examples are shown.

### **Stokes Flow In A Porous Tube With Arbitrary Injection And Suction At Tube Boundary**

C. K. Liu and M. T. Jasper

University of Alabama, University, and Mississippi State University, State College

S. W. Yuan in 1955 investigated a problem in incompressible fluid flow in a circular tube with radial seepage at the cylindrical surface. In his analysis he was able to separate the variables in the governing equations by assuming that the seepage velocity at the tube boundary is constant. This is, indeed, a very special case. Without this assumption of constant radial velocity at the boundary, analyses of this nature would become very difficult. However, if one is concerned only with the flows in the regime of low Reynolds Numbers, it is possible to simplify the mathematical formulation sufficiently to permit the incorporation of an arbitrarily prescribed radial velocity at the tube boundary. Such an analysis is presented in this paper. The resulting velocity and pressure fields are given in the form of definite integrals. Practical applications of this study can be found in ground water pumping and in heat pipe analysis.

### **Phase Measurements At Microwave Frequencies**

J. M. Loomis, III, M. D. Fahey, and E. R. Graf

Department of Electrical Engineering  
Auburn University, Auburn, Alabama

Proper phase relationships are necessary to operate phase-scanned antenna arrays. The phasing on the arrays is usually carried out in the antenna feed system. A method of making microwave phase measurements will be explored in this paper. Also equipment used, speed of making measurements, and accuracy of the measurements will be discussed.

### **The Stability Of Hinged Articulated Pipes Conveying A Fluid**

Raymond E. Malatino

University of Alabama  
University

The system investigated consisted of a chain of articulated rigid pipes conveying a fluid. One end of this system of pipes was fixed and the other end was free to move in the horizontal plane. An analysis was made of a two-degree-of-freedom system and determination of the stability of this system was shown to be dependent on the flow velocity. Also an investigation was made of a three-degree-of-freedom system to show the effect of an increase of articu-

lated pipes and the conditions of stability for this increase of pipes. It was shown, with an increase of pipes, that the critical flow velocity decreased. Therefore with an infinite number of pipes the critical flow velocity would be at a minimum. Hinge effects were also tested as to show their effect on the conditions of stability. The Lagrangian method was employed to derive the equations of motion of this system. The magnitude of the critical flow velocity was determined theoretically. An experiment was performed to validate the theoretical analysis of the investigation. Agreement between theory and the actual experimentation for the determination of the critical flow velocity was excellent. (Undergraduate Research Participation Program, supported by the National Science Foundation.)

## **The Response Of An Elastic Plate On A Winkler Foundation To A Concentrated Moving Normal Load**

Charles Mallory North, Jr.  
University of Alabama  
University

The dynamic response of airport runways and highway pavements to impact and moving loads is investigated. The system is simulated by a model consisting of an elastic plate supported by a Winkler foundation subjected to a concentrated moving normal load.

The response of the system to a moving load is shown to be the Duhamel superposition of the response to an infinite sequence of closely spaced stationary impulse loads. Hence, the problem of the response of the system to a stationary impulsive load is treated in detail.

The stationary impulse problem is solved by applying the methods of Laplace Transforms to the dynamic equations of motion of an elastic plate (which include terms accounting for rotary inertia and shear in much the same manner as Timoshenko's one dimensional beam theory). The solutions are written in terms of branch integrals which result from the complex contour inversion of the Laplace Transforms.

Numerical results illustrating the response of the system to both stationary impulse loads and moving loads are presented.

## **Equilibrium Radiation From Hypervelocity Impact**

T. D. McCay and K. E. Harwell  
Aerospace Engineering  
Auburn University, Auburn, Alabama

A hypervelocity impact flash can be represented as a high temperature plasma. A radiation model is set up with the intent of obtaining a radiation signature as a function of temperature, pressure, and time for different projectile-target combinations.

## **Vibrations Of Plates With Interior Line Fixities**

S. V. McGrath and T. E. Falgout  
University of Alabama  
University

The free transverse vibrations of thin plates with interior lines fixed against displacement and/or rotation are presented. For a given plate the response



$w(x, y, t)$ , the transverse displacement at point  $(x, y)$  in the plane of the plate at time  $t$ , to a unit harmonic force  $e^{i\omega t}$  applied at point  $x = \xi$  and  $y = \eta$  is determined. This yields a Green's Function,  $G(x, y, \xi, \eta, t)$  which permits an integral formulation for determining the displacement  $w(x, y, t)$  for any load distribution which is harmonic in time.

Consider a load function,  $P(\xi, \eta)$  distributed along the line to be restrained. This load is a function of the coordinates of the line and must be of a form which is linear in  $N$  undetermined constants,  $A_i$ ;  $i = 1, 2, \dots, N$ . The displacement  $w(x, y, t)$  is then required to have zero displacement and/or slope at  $N$ -discrete points along the line. This yields an eigenvalue problem with  $N$  homogeneous algebraic equations linear in the  $A_i$ ;  $i = 1, 2, \dots, N$  and with coefficients containing the eigenvalues  $\omega$ , the circular frequency of the harmonic load function.

An example problem is presented which compares the theoretically and experimentally determined eigenvalues.

## **Tape Recorders In Space Applications**

James McMahon  
Sperry Rand Corporation  
Huntsville, Alabama

This paper outlines the factors to be considered and the problems that arise in the design and manufacture of tape recorders for space applications. The major problem areas have been in the design of the tape handling mechanisms and in the manufacturing of the tape itself. Considerable effort has been expended in studying these problems and their effect on the data being stored and reproduced. The problems encountered have ranged from minor degradation of the signal to catastrophic. Approaches to these problems by several manufacturer's and user agencies are presented. Current problems and those anticipated in more extended space missions are considered.

## **Photo Stress Analysis Of Human Tooth**

W. H. Peters  
Department of Mechanical Engineering  
Auburn University, Auburn, Alabama

This paper shows the application of three dimensional, non-destructive photoelastic stress analysis to the stress analysis on a human tooth. The relation between the tooth and model will be justified, and problems encountered in making the model will be discussed. Finally, a general discussion of applications to the dental field will be given.

## **A Computer Program For Finding The Nonlinear Heat Transfer And Temperature Distribution Through A Constant Cross-Sectional Area Fin**

James W. Price  
NASA/George C. Marshall Space Flight Center  
Huntsville, Alabama

A. R. Shouman (NASA TM X-53621, dated June 14, 1967) obtained an exact general solution for the nonlinear differential equation governing the

one-dimensional steady-state heat exchange by composite radiation and convection along constant area fins with uniform temperature at the base and an arbitrary temperature gradient at the other end.

This solution has been computerized, and the heat transfer rate and the temperature profile for the fin are obtained using the following inputs:

1. Convection heat-transfer coefficient
2. Emissivity
3. Perimeter of the rod
4. Temperature of the base of the rod
5. Thermal conductivity of the rod
6. Cross-sectional area of the rod
7. Length of the rod
8. Temperature of the surroundings

### **Simplified Analysis Of Supersonic Boundary Layer Interaction With A Wedge Expansion**

Donald V. Rubin and Melbourne G. Briscoe  
U.S. Army Missile Command  
Redstone Arsenal, Alabama

The mechanics of interaction between a supersonic turbulent boundary layer and a corner expansion wave have been of increasing interest in recent years because of the desire to better understand base flows and wake flows in missile aerodynamic design. Prediction of the boundary layer properties downstream of the corner is normally accomplished by a computerized method of characteristics for non-isentropic flows.

This paper reports on the effectiveness of a simpler technique for the prediction of a turbulent boundary layer interaction with a wedge expansion, namely the use of an initial boundary layer profile at the corner in conjunction with a graphical solution of the *isentropic* characteristic equations for two-dimensional, inviscid, steady flow of a perfect gas. The results of our isentropic calculations are compared with data we have obtained from tests run at the von Karman Institute for Fluid Dynamics, Rhode-Saint-Genese, Belgium and with previous experimental wedge data.

It is shown that the simplified prediction of downstream wall pressures by graphical isentropic characteristics is a satisfactory technique for wedge angles of  $20^\circ$  or less.

### **An Optical Technique For Determining The Size And Concentration Of Carbon Particles In Flames**

Bill C. Tankersley  
University of Alabama  
University

There exists a need for a reliable method of calculating the radiant heat transfer from luminous flames. Present knowledge will not permit a calculation of the amount of soot formed in hydrocarbon combustion. Therefore, the calculation of radiant transfer from luminous flames cannot be separated from a determination of the concentration of soot in such flames.

Previous efforts of soot measurement have employed measurement of the scattered light when a monochromatic beam is incident on a flame. The primary difficulty involved with this method is the reliability of such "scattering"

measurements. Generally the scattered light is so small that it defies reliable measurement, even with multiplier phototubes. The transmitted light, however, is usually several orders of magnitude larger.

A technique for soot measurement utilizing measurements of the light transmitted through a luminous flame has been devised. The theory for the method is based on the classical Mie Theory. The theoretical portion of the work is essentially completed. This includes computer programs for generating the necessary theoretical data and reducing experimental data. The use of hypothetical, but realistic, values for experimental data in the program indicates the method will be limited only by experimental accuracy. Work is currently underway to obtain experimental verification of the technique. Experimental work will be conducted with flames as well as mediums of known particle size. The final results will include the theoretical development, experimental verification, and examples of typical applications.

### Selecting Sample Rates

Robert Vijil  
Sperry Rand Corporation  
Huntsville, Alabama

The instrumentation engineer is often so involved with the details of his own system that he becomes a black box expert who can tell all about the internal workings of his system, but nothing about its inputs and outputs. As a result of this situation, instrumentation systems have been misused. The Sampling Theorem is probably one of the most misunderstood and misquoted theories in use. This presentation will examine practical criteria which must be taken into account in designing a sampled data system.

Slides will be presented to show various problems encountered in data reconstruction when an inadequate sample rate is chosen. Various types of errors will be presented and traditional methods of interpolating between samples will be discussed. Interpolation is the process of determining what happens between samples. Since the subject material to be covered is quite broad, no attempt will be made to develop a rigorous mathematical model. The methods of interpolation to be discussed are: curve fitting, linear, step, filter, and computer.

### Analysis And Design Of Tracking Filter With Non-Unity Feedback

Glenn D. Weathers  
Sperry Rand Corporation  
Huntsville, Alabama

A tracking filter is basically a feedback control device. Feedback principles are employed to cause a voltage controlled oscillator to track the phase of an input reference signal. An important application of the tracking filter is the generation of carriers for demodulation of single sideband signals. The system for this application must be able to track the frequency variations of a pilot tone. Imperfect tracking creates errors in the phase of the synthesized channel carriers, and subsequent errors in the demodulated output.

The square wave is a particularly convenient VCO output when digital frequency dividers are used. The square wave cannot be used as an input to the

phase detector, however, because the harmonics would beat with higher frequency components of the composite multiplex resulting in superfluous error signals. A band pass filter placed between the VCO and phase detector would eliminate the harmonics problem, but the filter itself affects the loop tracking dynamics.

This paper outlines a tracking filter design procedure which includes the effect of the harmonic suppression filter. This procedure will yield a system with frequency response characteristics that are nearly identical to the standard tracking filter in the low frequency range.

### **Draining Or Filling Of Cryogenic Fluids From A Cylindrical Tank In Low G Environments—A Computerized Solution**

Carl T. K. Young  
Department of Systems Engineering  
University of Alabama, University

A computer solution is presented for the problem of draining and filling of an incompressible, nonviscous fluid from a cylindrical tank in low g environments. Because of the reduced gravitational influence, the formulation of this initial, mixed-type boundary value problem with axisymmetry includes a surface tension term in the dynamic boundary condition at the free fluid surface, and a contact angle (assumed constant) term in the boundary condition at the tank wall. Using actual dimensions of a S-IVB propellant tank, a flowrate of 80 lbm/sec, and a calculated initially static surface equilibrium configuration, computer programs were developed and run on an IBM 7094 computer for both processes of draining and filling of liquid hydrogen. The results of computation were presented as a series of instantaneous liquid surface shapes, each corresponding to a particular time level during the process. For a contact angle of  $90^\circ$ , the rising and lowering of the liquid level in the tank exhibit no marked difference from ordinary engineering experience; however, it is found that for a contact angle much less than  $90^\circ$ , the liquid adheres to the tank wall throughout the draining and filling processes, and that the liquid directly above the drain (feed) pipe experiences the greatest movement. Such movement would transpire, in the case of draining, a "blow-through" in the liquid bulk, resulting in a large amount of liquid residue in the tank. In the case of filling, this unduly great activity may cause loss of liquid through the vent, vapor-liquid mixing and excessive sloshing after the filling. Thus, the results of this study substantiate the need for careful design of tank configurations and fixtures used in connection with draining and filling of cryogenic fluids in low g environments.

### **Anthropology**

#### **Scientific Measurement In Social Science: Its Present State And Direction Of Development**

Jerry D. Cardwell  
Auburn University, Auburn, Alabama

This paper is a discussion of the current measurement techniques in social science and the problems associated therewith; an analysis of the developing

trends in social scientific methodology. A distinction is drawn between the language of theory and the language of research. It is suggested that the disparity between the two languages has created significant problems in social science measurement techniques and indicates that significant advancement in this area awaits the solution of the language differences. The language of theory is viewed as being couched in terms which are indicative of "cause," while the associated statistical measures usually allow only the expression of "association." The symmetry of the statistical equations is seen as a central problem. The claim is made that while there is symmetry in mathematical equations, error terms as used in recursive systems allow the utilization of regression equations as causal equations. It is further suggested that computer simulation of human behavior, while a most promising field, presupposed a mathematical system isomorphic with the language of theory.

## Archaic Quarring Industry In Central Alabama

David W. Chase  
Montgomery Museum of Fine Arts  
Montgomery, Alabama

Little attention has been paid to the search for the recording of lithic source sites in Central Alabama over the past years. Three material source sites are therefore described as typical and important as a part of industrial activity in Archaic times in this region.

In the river valleys of the Coosa, Tallapoosa and Alabama which extend into the crystalline rock structure areas, a large amount of pebble quartz gravel is found in numerous parts of riverine floodplains. This quartz gravel provided a prime source of raw material for the manufacture of weapon points and tools. A typical large workshop which reflects this industry is located one mile south of Wetumpka. There, the surface was found to be littered with chips, spalls and artifacts in various stages of manufacture together with hammerstones of coarse grained quartzite. The source of material was traced to a nearby stream bed where the gravel substrata was weathering out of the eroded ravine.

Earlier in 1968, a massive outcropping of steatite was found in Tallapoosa County. Examination of the formation disclosed it to be a large quarry site. Tool scars and gouged out depressions where bowl cores had been removed as well as three distinct tool types were found.

Later in the year, a large Tallahatta Quartzite site was located on the Turkey Creek in Covington County. This grainy scintillating material, often called "sugar quartz" by collectors was found to be cropping out adjacent to an old road bed. A great amount of debris was found to be scattered over the area and into the nearby forested areas bordering the creek bed. Large spalls and rejected specimens in various stages of manufacture were found in abundance. Several hammers were also found. The latter were quartz pebbles brought in from other areas and used for quarrying since they fractured less readily than did the Tallahatta quartzite hammers. The depth of the workshop debris — often one foot or deeper, indicated that the workshop site had been in use for a very long time.

Such source areas for lithic materials aid in augmenting data relating to trade activities as well as population movements among people in Archaic times.



## Missionaries And Anthropologists

Leon W. Gillaspie  
Department of Missions  
Southeastern Bible College, Birmingham, Alabama

The Christian missionary is a part of and a stimulus to the cultural change going on with increasing rapidity today. Missionaries are amateur applied anthropologists who need anthropological training. Much of the reason Christian missions have made mistakes is that they have preached a culture-bound or "western" Christianity and thus imposed parts of one culture onto another that really are not a part of Christianity at all.

The *message* of Christian missions may be outside the province of anthropology, but the *process of transmission*, the men who stand talking to each other, and the cultures which frame their thoughts and guide their reactions, these are all in the field of anthropology.

Christian missionaries have not always understood that they are, in reality, "culture change agents" and that anthropology has some principles that can facilitate their work. They have often been disillusioned by the hostility, cultural blindness, unscientific methods, and love for the exotic and "noble savage" of some anthropologists with whom they have had contact.

Some missionaries have made significant contributions to anthropology and an increasing number of mission boards are beginning to hire anthropologically trained men and require some anthropology courses for their trainees. Thus, as Christian missions begin to learn *from* anthropology, they can contribute *to* anthropology in return. As a corollary of the use of sound culture change principles, the missionary who lives with a people for a lifetime can reach into areas and aspects of cultures beyond the means and capabilities of most anthropologists.

## Major Cultural Transformations As Seen Through Letters To African Newspapers

Sarah A. Glass  
Samford University, Birmingham, Alabama

In Africa, one source of data for the analysis of cultural transformations, and the problems that accompany socio-cultural change, is found in letters to the editor and letters to advice columns of newspapers. This paper is an analysis of a letter written by a twenty-eight year old, college-educated man who has been married for three years to an illiterate girl. His wife was bought by his parents and sent to him without his consent. He is in love with an educated girl and would like to marry her.

The letter portrays the dilemma of young Africans who have received formal education in an urban setting, but find themselves still linked to the more traditional tribal society and its overwhelming emphasis on familism. It also points to the fact that the rate of culture change experienced by this generation is more rapid than that experienced by their parents, which further complicates matters. These young letter writers represent, perhaps, a new type of marginality, in that they are trying to operate within two systems, and are painfully caught by the great inconsistencies that exist between the two cultures.

## Pre-Literate And Alternative Concepts

Asael T. Hansen  
University of Alabama  
University

A praiseworthy motive evoked the concept pre-literate: The avoidance of the invidious terms savage, barbarous, and civilized. Savagery was low and bad; civilization, high and good; barbarism, in between. Pre-literate was intended to be non-evaluative. Still, the emergence of writing, some scholars felt, could serve as a reliable index of an associated cluster of innovations which constituted a major cultural transformation.

When things to be compared are as complicated as cultures, a taxonomy based on a single criterion is likely to encounter trouble. A ready example: The Inca Empire is pre-literate; numerous simpler peasant cultures have writing.

Perhaps a better one-trait index for the cluster of innovations alluded to is arithmetic. The Inca case proves that a few million humans can operate an empire without writing. But methods for keeping track of large quantities remains essential. Neither figuring in the head nor counting on fingers and/or toes can do the job.

Probably, one-trait approaches to comparing cultures should be abandoned. Broad groupings suggested by the presence or absence of writing and of arithmetic are dealt with more effectively by holistic concepts. Childe and others offer urban and pre-urban as useful terms. The terms pose the task of probing the multicomponent "thing" that an urban culture is and of showing how cultures of this kind differ from non-urban cultures — each of which is also a complex "thing." The procedure is tedious but leads to fewer booby traps than does reliance on a seemingly neat marker such as pre-literate.

## Excavations At The Palestinian City Of Ai

Karen Randolph Joines  
Samford University  
Birmingham, Alabama

The ruins of ancient Ai, reported in the Hebrew Bible to have been captured by Joshua near 1229 B.C., lie buried in the central hill country of Israel about ten miles north of Jerusalem. Our present expedition there, involving about 15 institutions and in cooperation with the American Schools of Oriental Research and the foreign currency program of the Smithsonian Institute, is staffed by about 25 professors and graduate students from America and Canada who direct the work of about 140 Arab laborers. Near 2900 B.C., when man was learning to write in lower Mesopotamia and the Egyptians were erecting the great pyramids, Egypt founded Ai as 27.5 acres in size, making it the largest excavated city constructed in Syria/Palestine until that time and one of the largest in the world. The city fell near 2500 B.C., lay vacated until about 1200 B.C. when it was resurrected, but only as an unfortified village of about three acres. This city lasted until about 970 B.C. again to be abandoned until about A.D. 300 when the mound's terraces were used for farming.

The expedition cleared also part of a Byzantine monastery complex and several Jewish and Christian graves nearby from the Roman and Byzantine period.

## A Comparison Of Effigy Heads From Alabama

Carey B. Oakley Jr.  
University of Alabama  
University

This paper is presented as a follow up on a previous paper given by Mr. Steve B. Wimberly (Indian Pottery Human Effigy Heads From The Mobile Bay Region Of Alabama. *Journal of Alabama Archaeology*, Vol. XIV: No. 1. 1968.). As with his paper I have made no effort to exhaust the study of effigy heads but rather to gain additional insight into the possible value effigy heads might have in the analysis of a prehistoric culture.

The results of a brief comparison of ceramic effigy heads from two regions, specifically the Mobile Bay area in Mobile and Baldwin counties and the very large Mississippian ceremonial center at Moundville, Alabama, illustrate similarities exist predominately in the method of construction. All of the heads from the two areas are from shell tempered vessels; both solid and hollow ceramic heads are present with some of the hollow types containing rattles. It has been observed that all of the heads from the Mobile Bay region were attached vertically, extending above the rim of the bowl. At Moundville this technique of attachment was present but another technique was also noted. This latter technique involved the attachment of the head perpendicular to the rim with applique appendages for the arms and legs.

The presence of a forelock was evident on nine of the twelve specimens from the Mobile Bay region but may have been present on only two of the heads from Moundville. Hair styles were varied among the Moundville heads while they were fairly consistent on the Mobile Bay heads. The Moundville types were on the average somewhat smaller than their Mobile counterparts.

With the aid of more research on this subject the author feels that an analysis of ceramic effigy heads can be of considerable importance in yielding information about the Mississippian Period.

## The Anthropology Curriculum In Alabama Colleges And Universities In 1969

Margaret Zehmer Searcy  
University of Alabama  
University

The demand for anthropology as an integral part of the college curriculum is becoming increasingly apparent. A questionnaire was prepared and sent to many of the institutions of higher learning in December 1968 to determine the department's status, the qualifications of the staff members, and the course offerings. In the event that the questionnaire was not returned information was compiled from the college catalogue. The survey is not complete, and it may not be infallible since many catalogues are out of date and many institutions are in the process of change. A schedule showing a breakdown of all personnel, courses and departments by each of the 53 institutions is available upon request.

The University of Alabama at Tuscaloosa is the only institution of the 53 which offers either a major or minor and a master's degree. No doctoral program is found in the state. Twenty-one institutions teach one or more courses, but this figure is misleading because anthropology may be taught only one

semester every two years in several of these schools. Out of the entire state only 12 faculty members were reported to have specialized training in anthropology. One half of these teach other subjects in addition to anthropology. Only five had terminal degrees; the other seven had a master's degree. All of the professionals are employed by four-year colleges and universities.

In conclusion, the picture of anthropology in Alabama is a very discouraging but challenging one.

## Diffusion Of European Folk Housing To America

Eugene M. Wilson

Department of Geology and Geography  
University of Alabama, University

Certain of our old rural houses in Alabama illustrate diffusion of folk house types from Europe to America. Two important types are the single room house and the "dogtrot" or central hallway house which was our most popular type in Alabama. Folk houses were designed by local carpenters and handy-men who built houses according to well established custom. In the South, the basic housebuilding customs were derived from Europe, especially from Britain and Germany, where they had become established by the Middle Ages.

The American "one-bay" house type was primarily of British origin. Its dimensions were based upon the rod length of 16 feet, thought to be derived from the stall space required by four oxen commonly used for pulling the medieval mouldboard plough. One-bay houses were abundant in the early English Tidewater settlements in the seventeenth century.

The central hallway house was once widespread over Northwestern Europe. It appears to have developed in Central Europe from the partitioning of the single room, central hearth houses by isolating the hearth from the living room and the animal stalls. The central hallway house was also present in the Tidewater before 1700 but it could have been introduced by the English, Swedes or Germans, all of whom shared, at one time, the use of this house plan. These two important folk house types serve to illustrate our connections to Medieval Europe and diffusion of folk culture traits to America.

# MINUTES

## Annual Business Meeting

### Auditorium, Mobile College, Mobile, Alabama

### April 12, 1969

The Annual Business Meeting of the Academy was called to order by President Wheeler at 11:00 A.M.

The minutes of the April 6, 1968 business meeting were declared approved as mimeographed and distributed to the membership.

The announcement was made that the award for graduate students would be abolished.

President Wheeler announced the place of the annual meeting for the next 3 years. The 1970 annual meeting will be hosted by Auburn University on April 9-11. The 1971 meeting will be hosted by the University of Alabama. The 1972 meeting will be hosted by Jacksonville State University.

**REPORT OF THE SECRETARY (Spencer).** Registration for the 1969 meeting reached 304. There were representatives from 54 institutions and agencies exclusive of high schools registered. The registration by section affiliation was as follows:

I. Biological Sciences .....	79
II. Chemistry .....	26
III. Geology .....	5
IV. Forestry, Geography and Conservation .....	14
V. Physics and Mathematics .....	48
VI. Industry and Economics .....	9
VII. Science Education .....	20
VIII. Social Science .....	15
IX. Medical Sciences .....	18
X. Engineering .....	21
XI. Anthropology .....	9
Miscellaneous .....	40
<b>TOTAL .....</b>	<b>304</b>

Summary of Membership was as follows:

Total Membership December 31, 1967 .....	929
Total Membership December 31, 1968 .....	997
Net Gain .....	68
Total Membership April 4, 1969 .....	1095

**AUDITING COMMITTEE FOR THE ALABAMA ACADEMY OF SCIENCE (Mountcastle).** The Auditing Committee of the Alabama Academy of Science, Senior Academy of Science, has examined the books of the Senior Academy and finds them in order.

Balance: 4/1/69 .....	\$3,955.52 (Checking)
	\$6,623.43 (Savings)

In addition, the NSF accounts of the two Academics, Junior and Senior, have been found to be in order.

The committee wishes to commend Dr. John M. McKibbin, Treasurer, and Dr. Herbert McCullough, Administrator, NSF funds.



It was moved that the report be accepted. The motion was carried unanimously.

**RESOLUTIONS COMMITTEE** (Furman). WHEREAS, the Alabama Academy of Science has held its Forty-Sixth Annual Meeting at Mobile College and has enjoyed the hospitality of the College, therefore:

**BE IT RESOLVED** that the Academy express its gratitude to Dr. William K. Weaver, President of Mobile College, Dr. A. Garrett Hill, General Chairman of Local Arrangements, and to the Chairmen of the local committees: Dr. H. Clyde Eyster, Dr. Nelson A. Lloyd, Mr. George A. Smith, Mr. Kenneth W. Lemmon, Dr. Vonceil McLendon and Mrs. Sandra Thacker and to their committees and to the Faculty and Staff of Mobile College and to all others who have contributed to the success of the meeting;

**BE IT FURTHER RESOLVED** that the Academy express its gratitude to the Sargent-Welch and Company for the annual banquet.

It was moved and seconded that the resolutions be adopted. The motion passed unanimously.

WHEREAS, during the past year the Alabama Academy of Science has lost six of its members through death, therefore:

**BE IT RESOLVED** that the Academy extend its sympathy to the families of Carl E. Frisby, Dr. Estes H. Hargis, Augustus J. Harris, Dr. Clarence T. Mason, Emmett W. Price and W. D. Salmon;

**BE IT FURTHER RESOLVED** that the members of the Academy assembled in this Annual Business Meeting express their appreciation for the great contributions of these departed members to the Academy by rising and standing for a moment of silent prayer;

**BE IT FURTHER RESOLVED** that appropriate letters together with a copy of this resolution be sent by the Secretary of the Academy to the families of these departed members.

It was moved and seconded that the resolutions be adopted. The motion passed unanimously.

**NOMINATING COMMITTEE** (Steele). See inside front cover.

**RESEARCH COMMITTEE** (Diener). In the graduate division in Biology, G. Y. Wen was awarded first place and D. P. Orbin was second. In the undergraduate division in Biology, J. Don Franks read the winning paper and Robert Owen presented the second one.

**AJAS AND JSHS REPORT** (Thomas). Dr. Thomas gave a report that there were 155 registered with the AJAS and 120 registered with the JSHS. The new officers of the Junior Academy were then introduced by Dr. Thomas.

**REGIONAL SCIENCE FAIR** (Mrs. Rosemary Crawford). Six regional science fairs of Alabama have selected two Finalists each to represent their region at the International Science Fair to be held in Fort Worth, Texas, May 5-9. The Finalists are:

Central Region, Samford University – Audrey Goins, William Rembert.

Mobile Region, Spring Hill College – June Bliss, Tommie Peterson.

Northern Region, Huntsville Center, U. of A. – Flavin Williams, William London.

Northeastern Region, Jacksonville State Univ. – Larry Lewis, Thomas Guffin.

Northwestern Region, Florence State Univ. — Victoria Wilson, Billus Goodwin.

Western Region, University of Alabama — Margaret Kallsen, Hans Liu.

**GORGAS FOUNDATION** (Feazel). The Gorgas Scholarship Foundation today announced the winners of this year's Gorgas Science Scholarships, each consisting of a cash award plus tuition at an Alabama college or university.

The first award, for \$450 per year, was won by Joseph M. Sherrill, 3830 South Cove Drive, Birmingham, a student at Mountain Brook High School; the second, for \$337.50 per year, by John L. Brown, 2401 Fifth Place, N.W., Birmingham, a student at Erwin High. The third award, for \$225 per year, went to Woodrow E. Garmon, 326 Mark Street, S.W., Decatur, a student at Austin High, and the fourth award, for \$187.50 per year, to Roger A. Peirce, 510 East Hargrove Road, Tuscaloosa, a student at Tuscaloosa High.

Alternates are first, Andrea J. Yates, Austin High; second, Vincent D. Pearson, Scottsboro High; third, Ronald R. Parker, Austin High; fourth, Margaret L. Kallsen, Tuscaloosa High; fifth, Johnny A. Waters, Lawrence County High; sixth, Charles T. Brown, Lanier High; seventh, Susan Kay Hill, Ramsay High.

The winners were selected by a panel of judges at the Annual Meeting of the Alabama Academy of Science held at Mobile College on April 11-12.

The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal Zone while serving as Surgeon of the U.S. Army. The purposes of the Foundation are to promote interest in science and to aid in the education of promising students.

President Wheeler introduced the speaker for the hour, Dr. Charles J. Boyle, Springhill College, who gave an outstanding address to the joint meeting.

President Wheeler introduced the incoming President, Dr. W. B. DeVall, and turned the meeting over to him.

The President adjourned the meeting at 12:00 Noon.

G. O. SPENCER, Secretary









# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

VOLUME 40

OCTOBER, 1969

NUMBER 4

MAR 17 1972

THE AMERICAN MUSEUM  
OF NATURAL HISTORY



**THE JOURNAL**  
**OF THE**  
**ALABAMA ACADEMY**  
**OF SCIENCE**

**AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE**

**VOLUME 40**

**OCTOBER, 1969**

**NUMBER 4**

**EDITOR, PRO TEM.**

**Robert T. Gudauskas**  
**Auburn University**

**ARCHIVIST**

**Clyde H. Cantrell**  
**Auburn University**

**EDITORIAL BOARD**

**Lowell Wilson, Chairman**  
**Auburn University**

**Dan C. Holliman**  
**Birmingham-Southern**  
**College**

**Ann Everett**  
**Crossville High**  
**School**

*E. L. McGraw, Auburn University, Editorial Consultant*

---

**The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.**

**The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.**

## CONTENTS

### ARTICLE

Some Observations of Female Grackle Ethology During the Period of Nestling Ethology Zeno E. Bailey .....	219
Population Density Fluctuations in a Heron Nesting Colony Julian L. Dusi .....	223
Calculation of Carbon Dioxide Partial Pressure from Chemical Analyses of Limestone Ground Water John L. Sonderegger .....	227
Occurrence of <i>Clavagella armata</i> Morton in Perry County, Alabama Michael W. Szabo .....	233
Transmission Electron Microscope Study of Ostracode Carapace Ultrastructure Ronald S. Taylor .....	238
A Brief History of Blakeley, Baldwin County, Alabama Thomas A. McMillan and Harold O. Beals .....	242
History Teaching in the High Schools Andrew M. Weaver .....	246
Experimental Determination of Permeability of 100, 250 and 400-Mesh Stainless Steel Screens B. G. McKinney and T. J. Overcamp .....	253
An Empirical Analysis of Growth and Decline in Levels of Retail Sales in Alabama and the Southeast Joseph Barry Mason, Morris L. Mayer, and Charles Thomas Moore .....	258
Index .....	269

# Observations of Female Grackle Ethology

## SOME OBSERVATIONS OF FEMALE GRACKLE ETHOLOGY DURING THE PERIOD OF NESTLING DEVELOPMENT

Zeno E. Bailey  
Department of Biology  
Livingston University  
Livingston, Alabama

### INTRODUCTION

Largest of the Icterids, the male Boat-tailed Grackle (Cassidix mexicanus prosopidicola) is a very large iridescent blackbird, over a foot in length characterized by a wide, keel-shaped tail. The female is brown, much shorter than the male, and has no keel-shaped tail (5).

The large yellow-eyed males are known as "jackdaws" or "clarineros," while the smaller brown females are referred to as "sanates" (3). Widely distributed, the Boat-tailed Grackle is found at sea level as well as elevations of 7,000 feet. The species seems equally at home in the most humid districts of the Atlantic littoral as well as amid cacti and thorny shrub of the scorching semi-desert region.

The nest, an open cup, is constructed of available plant materials and usually is lined with mud and secured to cattails or bulrushes growing in the water. In the absence of a lake or pond environment it will nest in trees and shrubs but tends to avoid dense forested areas. An average clutch of 3 light-blue to glaucous-green eggs overlaid with burnt-amber and lines is laid within a period of 5 to 10 days. Incubation begins when the second egg is laid and the young hatch in approximately 14 to 16 days (6).

First observed in Hunt County, Texas, in 1949<sup>1</sup>, the grackle has become a regular spring migrant that rears a brood of young and leaves the area early in August. The species has recently become a permanent resident as far north as Dallas<sup>2</sup>. The progressive, northward migration prompted me to initiate this study which I hoped would eventually culminate in a complete investigation of the bird's life-history.

This phase of the overall investigation was concerned primarily with female ethology during the period of nestling development. The purpose of this study was to determine if there was a relationship between the frequency of visits to the nest and the time of the day; and if there were predictable patterns of approaching the nest, feeding the young, and departing the nest to the feeding area.

### METHODS AND MATERIALS

An observation blind was constructed near the nesting site when evidence of nest building was first observed. Framework for the blind consisted of two "U" shaped metal rods over which brown burlap was

<sup>1</sup>O'Neil, Nora; Personal correspondence

<sup>2</sup>Pulich, Warren; Personal correspondence



stretched and anchored to the ground. Placement of the blind near the nesting site some time prior to the beginning of the nestling feeding period was based on the assumption that the females would become accustomed to the presence of the structure and would likely assume more normal behavioral activity when the feeding period began. When the early morning observation schedules were being conducted, I entered the blind prior to dawn. For other observation periods, the blind was entered as quietly as possible but no data were recorded until 10 minutes after entrance.

Due to dense vegetation and the concentration of a large number of nests within a very small area, it was necessary to limit the number of nests which could be observed accurately. The two nests, designated 1 and 2, selected for observation were located far enough from each other that the activity of each female could be observed accurately. Females visiting these nests were observed from June 16 through June 22 when both nests were destroyed by predators. To continue the study two new nests, designated 1a and 2a, were selected and observed from June 26 through July 2.

For the duration of a 14-day period (June 16 through July 2, 1967) the following observation schedules were maintained:

Schedule I: 5:45 to 7:45 A.M.; June 16 through 22  
Schedule II: 6:30 to 8:15 P.M.; June 16 through 22  
Schedule III: 8:45 to 10:45 A.M.; June 26 through July 2  
Schedule IV: 3:15 to 5:15 P.M.; June 26 through July 2

## RESULTS

### *Frequency of Nest Visitation*

Female activity as indicated by frequency of visits to nests was most intense early in the morning and late in the afternoon (Fig. 1). It should be noted that activity between 5:45 and 6:45 A.M. and 6:30 and 7:30 P.M. was most intense. Except for the period from 9:45 and 10:45 A.M., there was progressively less activity between 6:45 A.M. and 5:15 P.M.

Maximum time interval between visits was least for females visiting Nests 1 and 2, while it was greatest for Nest 2a (Table 1). Activity at Nest 1 was most intense of all nests studied. This was evidenced by the total visits by the female as well as the average number of visits per hr. Maximum time interval in minutes between visits to the nest was less for Nest 1 than for other nests. Fifty-eight percent of all visits were made in the morning, while only 42 percent were made in the afternoon. When only morning visits are considered, 37 percent were made before 6:45 A.M. and only 20 percent were made after 9:45 A.M. On the otherhand, 64 percent of all afternoon visits occurred after 6:30 P.M., but only 36 percent were made between 3:15 and 5:15 P.M.

The number of visits to the nest per hr by the female varied from a maximum of 11 to a minimum of less than one. An average of 5.35 visits per hr was observed for all of the nests studied. Nice (4) reported that the feeding frequency for passerines varied from 8.4 to 0.8, with an average of 4 feedings per hr per nestling. Allen (1) observed a Great Crested

## Observations of Female Grackle Ethology

Fly Catcher feed five nestlings 91 times between 5:12 A.M. and 12:10 P.M. Feeding rate varies not only among the species and with the age of the young but also with the length of the nestling period, with weather conditions, and with the number of young to be fed.

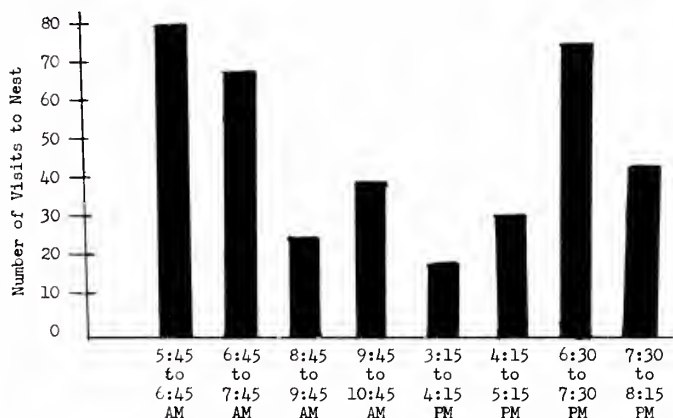


FIGURE 1. Relationship between time of day and frequency of nest visitation by the female.

TABLE 1. Female grackle activity at the nesting site during a 14-day observation period.

Nest Number	Total Visits	Interval between visits (min.)			Average visits/hr
		Maximum	Minimum	Average	
1	143	28	2	13	5.8
1a	67	54	5	16	2.5
2	112	44	2	21	4.0
2a	43	84	10	36	1.5

### *Female Behavior at the Nesting Site*

During the first week of observation a fairly routine pattern of female behavior began to emerge. Upon returning from the feeding area, the female would fly directly to the cattails and alight some 5 to 10 ft away from her nest. She would remain for 20 to 30 sec and then fly or hop to within 2 to 3 ft of her nest, remain perched for 10 to 15 sec, and

then hop and alight on the cup rim of the nest and feed her young. Duration of the feeding period seldom exceeded 60 sec. Leaving her nest promptly, she would fly directly south over the pool and continue in the same direction until disappearing from view. Even when her flight destination was toward the east, she would fly south until she had passed over the pool. Then, she would turn sharply toward the east and continue in this direction until disappearing from view.

When nest cleaning chores were to be performed the behavior of the female was somewhat different. After feeding her young, she removed the fecal sac from the nest and departed holding it in her beak. Having cleared the cattails, she would release the sac and drop it into the water as she flew toward the center of the pool where she alighted on a fence post. While remaining perched for 30 to 60 sec, she would often drink water before departing south to the feeding area. From 6:00 to 7:00 A.M. 5 fecal sacs were removed by one female. During a 7-day observation period, 84 fecal sacs were removed from the nest by the female and dropped into the water at some distance from the nesting site.

Direction of departure assumed by the female following nest visitation was recorded following 298 visits. Fifty-one percent of all departures were toward the south, 41 percent were toward the east, 7.5 percent were toward the west, and less than one percent toward the north. There was no apparent explanation for the infrequent use of the west and north quadrants as feeding areas.

#### CONCLUSIONS

Frequency of nest visitation was highest during early morning and again during late afternoon hours, and was the lowest during the part of day when wind velocity and heat intensity were the highest. Fifty-eight percent of all visits were made in the morning, while only 42 percent were made in the afternoon. When only morning visits were considered, 37 percent were made before 6:45 A.M. and only 20 percent were made after 9:45 A.M. Sixty-four percent of all afternoon visits occurred after 6:30 P.M., but only 36 percent were made between 3:15 and 5:15 P.M.

Following hatching of the young, the female soon established a fairly routine pattern of approaching the nest, feeding her young, and departing to the feeding area. Attention to nest sanitation and care also tended to fall into a somewhat predictable pattern.

#### LITERATURE CITED

1. Allen, Arthur A. 1961. The book of bird life. D. Van Nostrand Company, New York. 118 p.
2. Berger, Andrew J. 1961. Bird study. John Wiley and Sons, New York. 257 p.
3. McIlhenny, E. A. 1937. Life history of the boat-tailed grackle in Louisiana. Auk 54: 274-295.
4. Nice, M. M. 1943. Studies in the life history of the song sparrow. II Trans. Linn. Soc. New York 6.
5. Peterson, Roger T. 1960. A field guide to the birds of Texas. Houghton-Mifflin Company, Boston, Mass. 233 p.
6. Selander, Robert K. 1960. Sex ratio of nestlings and clutch size in the boat-tailed grackle. The Condor. 62: 34-44.

## Population Fluctuations in Heron Colony

### POPULATION DENSITY FLUCTUATIONS IN A HERON NESTING COLONY

Julian L. Dusi

Department of Zoology - Entomology  
Auburn University, Auburn, Alabama

Population density in a heron colony fluctuates greatly during the breeding season and is dependent upon the species present and their breeding activity at the time in question. An illustration of these fluctuations is seen in the data gathered during the nesting season of 1968 from a breeding colony near Dothan, Alabama. My wife and I gathered the data as part of our ecological study supported by the Water Resources Research Institute at Auburn University using several different ways of counting:

- (1) Herons are large enough to count from an airplane at an altitude of about 1,000 ft above the surface. Very large numbers are difficult to count accurately since the counters position is rapidly changing. This is a momentary estimate.
- (2) Active and inactive nests can be counted by carefully walking through the colony area. This permits fairly accurate enumeration of nests and young-in-the-nests but yields little adult data unless it is assumed that there are two adults per nest, as a minimum estimate. The count requires several hr, much energy, and identification ability.
- (3) The evening roosting count is an accurate method of enumerating the numbers of adults and immatures that fly into the colony area in the evening. This requires a co-ordinated effort of two or more workers, who can watch the area from vantage points for several hours. It does not give information of the numbers of adults and young already in the colony area when the count is begun. Usually, it is not physically possible to use all of these methods on the same day. Therefore, some error is inherent in making comparisons.

Data collected in this study were gathered in the following sequence of observations: March 19 - A flight over the colony and down the Chattahoochee River to Blountstown, Florida, where the nearest Cattle Egrets were seen; April 27 - A nest count and approximate estimate of the evening flight; June 9 - Evening count; June 23 - Nest count; June 30 - Flight estimate; July 7 - Nest count; July 26 - Evening count; July 27 - Nest count; August 11 - Evening count; and, September 10 - Flight estimate.

The following summary of population densities is given in order of species dominance:

- (1) *Cattle Egret* (Fig. 1) - This species is now the most common wading bird in Alabama and in this colony. They were first seen on April 27 and estimated at 300, but no nests were present. On June 9, the count

was 6,788 as major nesting began with 2,110 nests, mostly Cattle Egret, counted on June 23. A flight over the area June 30 showed only 300 in the colony but on July 7, 2,087 nests were still active. The evening count on July 26, was 5,715 and on July 27, only 122 nests were still active with 1,418 young estimated in the nests. The August 11 evening count was 3,593 and finally a flight on September 10, showed only 4 in the adjacent pasture.

(2) *White Ibis* (Fig. 2) - This species is fairly common in most of the lower coastal plain colonies. This year they were recorded March 19, when 16 were seen. No nests were present on April 27, but 637 flew in on June 9, and 265 nests were present June 23. By July 7, nests declined to 78. The July 26 evening count was 430 but the nests on July 27, were only 8 and 67 young were counted in the colony. The August 11, evening count was 104. This included flying young of the year and adults.

(3) *Little Blue Heron* (Fig. 3) - Formerly the most abundant heron in inland colonies, this species now has declined greatly. They are usually early nesters and the nesting season is usually short. On April 27, 30 nests were present with three or four eggs present in most. The June 9, evening count included 440. The June 23, nest count contained only four Little Blue Heron nests. Some of the many Cattle Egret nests could have been misidentified and were actually Heron nests. However, this was definitely the end of the Heron breeding. The July 26, evening count contained 430 and the August 22, count 152, with dispersal of adults and juveniles well under way.

(4) *Miscellaneous Species* - Common Egrets, Snowy Egrets, Anhingas and occasionally other species were present but usually in such small numbers that no valid counts could be made.

The very low population density of March 19, rose to almost 9,000 individuals or almost 700 per acre on June 9. This density was reduced slightly but held fairly steady until August 11, when it decreased to about half, and by September 10, the birds had left (Fig. 4).

Nesting effort of Little Blue Herons started on April 27, and was finished by June 30. White Ibis and Cattle Egret nesting was not well under way until June 23, so that their nesting barely overlapped that of the Little Blue Herons and then it continued until July 27. After that, adults and young of all species started their post-breeding dispersal and the breeding, roosting, and nestling population densities declined rapidly until early September when practically all individuals were gone.



# Population Fluctuations in Heron Colony

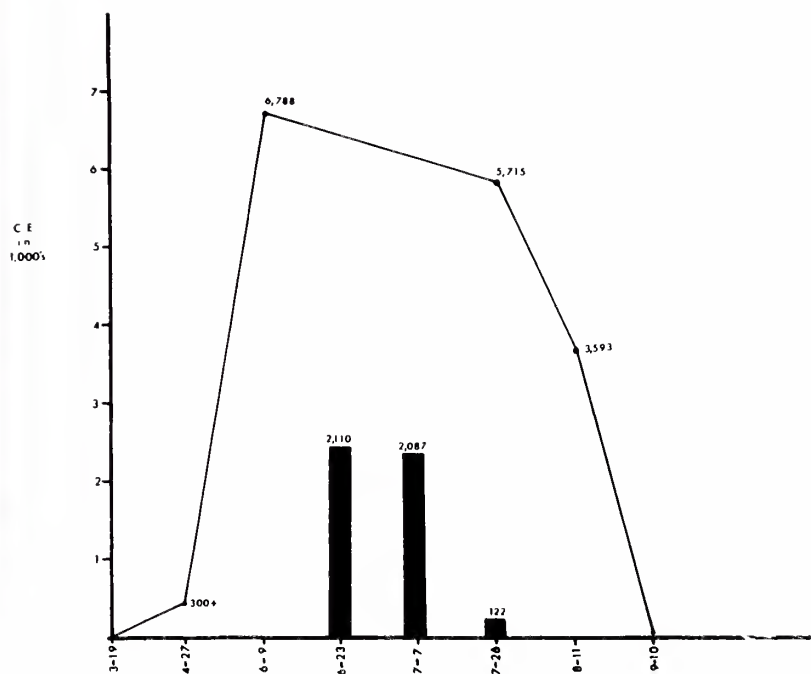


FIGURE 1. Population density (adults and nests) of Cattle Egrets.

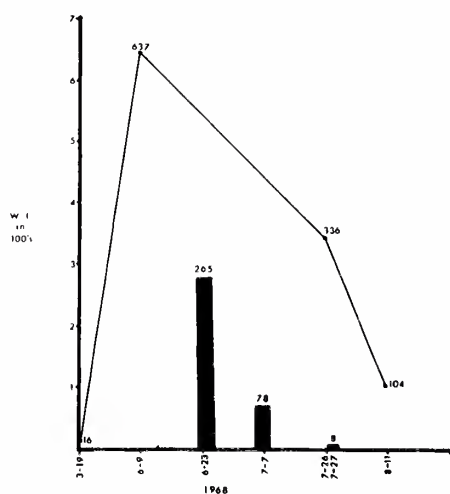


FIGURE 2. Population density (adults and nests) of White Ibises.

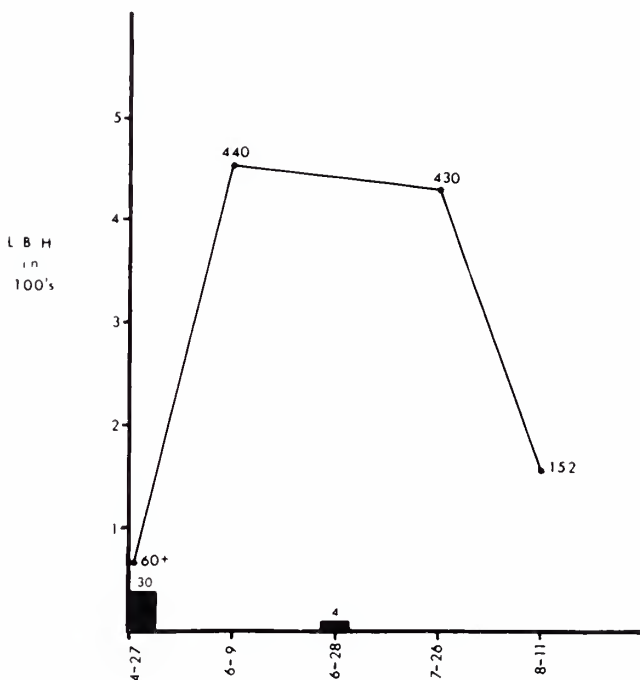


FIGURE 3. Population density (adults and nests) of the Little Blue Heron.

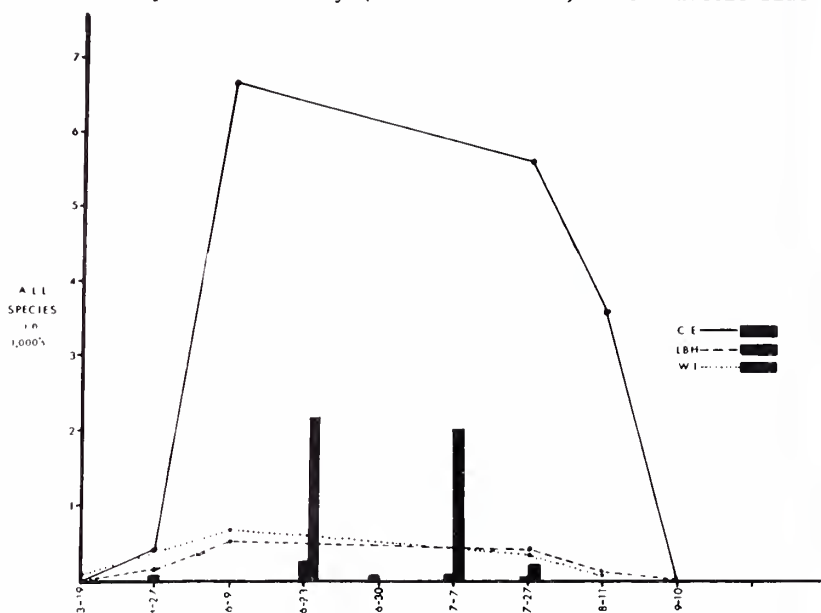


FIGURE 4. Population density (adults and nests) of all species.

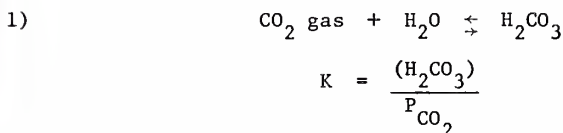
## Calculation of Carbon Dioxide Pressure

### CALCULATION OF CARBON DIOXIDE PARTIAL PRESSURE FROM CHEMICAL ANALYSES OF LIMESTONE GROUND WATER

John L. Sonderegger  
Department of Geology  
University of Alabama, University

#### INTRODUCTION

Carbon dioxide gas reacts with water to form carbonic acid.



The equilibrium constant for the reaction is  $K$ ,  $(\text{H}_2\text{CO}_3)$  is the concentration of carbonic acid, and  $P_{\text{CO}_2}$  is the partial pressure of carbon dioxide measured in atmospheres. The extent to which the acid dissociates is pH dependent and from this relationship,  $P_{\text{CO}_2}$  may be calculated from bicarbonate concentration and pH. The method is valid only under the following conditions:

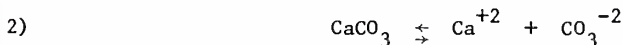
1. The water sample must plot within  $\pm 0.5$  pH units of equilibrium with the  $\text{Ca}^{+2}$  and  $\text{HCO}_3^{-1}$  ion concentrations (Fig. 1).
2. The analysis must indicate a small concentration, less than  $10^{-3}$  moles per liter, of other cations and anions.

Water samples from shallow limestone aquifers commonly meet these requirements.

#### THEORY

The system of ground water in a carbonate aquifer at or near equilibrium with the bedrock may be analyzed as two subsystems, the calcite-water system and the carbon dioxide-water system.

##### *Calcite-Water System*



$$K_{sp} + (\text{Ca}^{+2}) \cdot (\text{CO}_3^{-2}) = 10^{-8.22} \text{ at } 15 \text{ C}$$

The solubility product,  $K_{sp}$ , is dependent upon the  $\text{Ca}^{+2}$  cation concentration, the  $\text{CO}_3^{-2}$  anion concentration and the temperature. The average ground-water temperature in the area of research (Limestone County, Alabama) is 15 C. All equilibrium constants have been corrected from 25 C to 15 C.

*Carbon Dioxide-Water System*

When pure water is exposed to air, the water dissolves carbon dioxide from the atmosphere. Some of the dissolved carbon dioxide

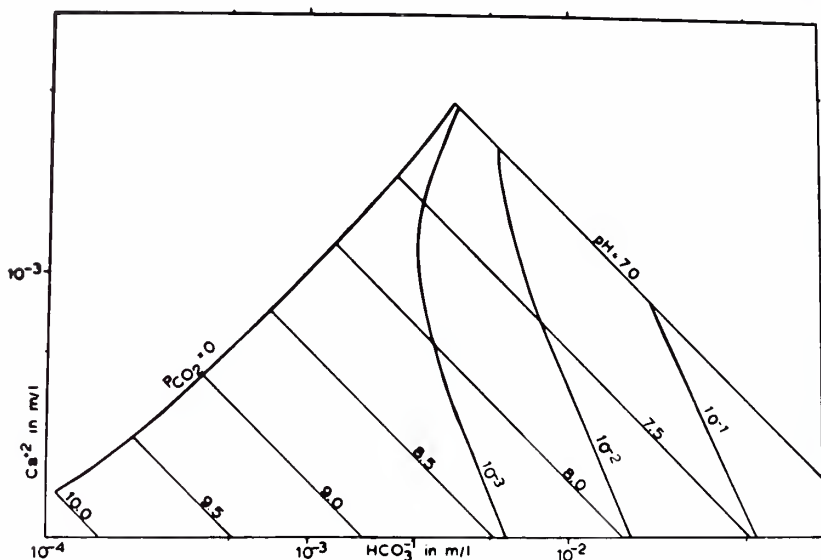
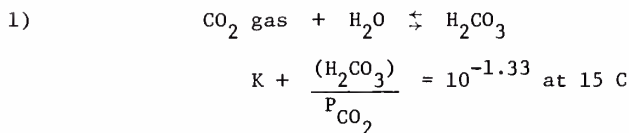
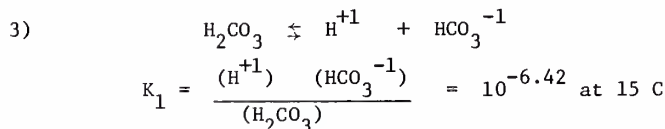


FIGURE 1. Graph showing partial pressure of  $\text{CO}_2$  at various ionic concentrations of  $\text{Ca}^{+2}$ ,  $\text{HCO}_3^{-1}$ , and  $\text{H}^+$ .

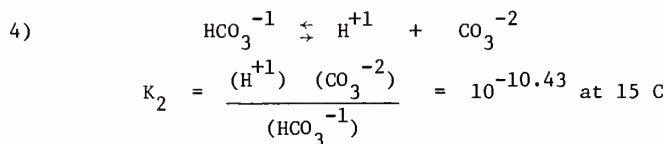
is then converted to carbonic acid,  $\text{H}_2\text{CO}_3$ .



and as ionization occurs



and



## Calculation of Carbon Dioxide Pressure

Thus in dilute solutions, at a pH less than 6.4, carbonic acid is the dominant form; from pH 6.4 - 10.4, bicarbonate is the dominant form; and at pH values above 10.4, the carbonate radical is the dominant form.

### *Mass Balance Approach*

Two principal sources exist for the origin of all carbonate species in the ground water of a carbonate aquifer: the solution of limestone (eq. 2) and the conversion of carbon dioxide gas to carbonic acid (eq. 1) with the subsequent ionization of the carbonic acid (eqs. 3 and 4). If carbonate is not added to the system from external sources, and if other divalent cations are neither added nor subtracted from the system, the system may be analyzed and the influence of  $P_{CO_2}$  computed. Increased partial pressure of carbon dioxide permits increased solution of limestone, hence, areas with high  $P_{CO_2}$  values should be areas where solution activity is greatest.

For simplicity of presentation and use, two limiting assumptions are made:

1. Activity coefficients of the ionic species are near unity.
2. The concentration of ions other than calcium and the carbonate species is less than  $10^{-3}$  moles per liter.

A pure limestone, when dissolved in pure water, yields calcium ions ( $Ca^{+2}$ ) as well as the three carbonate species ( $H_2CO_3$ ,  $HCO_3^{-1}$ , and  $CO_3^{-2}$ ) (4). In a closed system, the concentration of calcium equals the concentration of the three carbonate species:

$$5) \quad (Ca^{+2}) = [ (H_2CO_3) + (HCO_3^{-1}) + (CO_3^{-2}) ]$$

For convenience, the summation of the carbonate forms will be represented as:

$$6) \quad \Sigma CO_3 = (H_2CO_3) + (HCO_3^{-1}) + (CO_3^{-2})$$

and if  $\Sigma CO_3 > (Ca^{+2})$ , then

$$7) \quad (\Sigma CO_3) - (Ca^{+2}) = (\Delta CO_3)$$

The  $\Delta CO_3$  term in a pure system can result only from the partial pressure of carbon dioxide contributing carbonate to the solution.

Laboratory analyses of ground water from limestone aquifers commonly will include only the bicarbonate concentration, ( $HCO_3^{-1}$ ), of the water sample. The concentration of  $H_2CO_3$  and  $CO_3^{-2}$  must be calculated from the  $HCO_3^{-1}$  concentration. Rearranging equilibrium equations 3 and 4 yields:

$$8) \quad (H_2CO_3) = (HCO_3^{-1}) \times \frac{(H^{+1})}{K_1}$$



$$9) \quad (\text{CO}_3^{-2}) = (\text{HCO}_3^{-1}) \times \frac{K_2}{(\text{H}^{+1})}$$

Now the total carbonate concentration,  $\Sigma \text{CO}_3$ , may be expressed as:

$$10) \quad (\Sigma \text{CO}_3) = (\text{HCO}_3^{-1}) \times \left( 1 + \frac{(\text{H}^{+1})}{K_1} + \frac{K_2}{(\text{H}^{+1})} \right)$$

The solubility of carbon dioxide may also be represented in terms of bicarbonate concentration:

$$11) \quad K = \frac{(\text{H}^{+1}) (\text{HCO}_3^{-1})}{K_1^{\text{P}} \text{CO}_2}$$

or

$$\text{P}_{\text{CO}_2} = \frac{(\text{H}^{+1}) (\text{HCO}_3^{-1})}{K_1 K}$$

#### APPLICATION TO GRAPH

The graph (Fig. 1) shows the relationship of the ion concentrations to pH, and  $\text{P}_{\text{CO}_2}$ . Concentrations of  $\text{Ca}^{+2}$  and  $\text{HCO}_3^{-1}$  in moles per liter are shown on the sides of the diagram. Each sample may be represented by a point. The diagonal pH lines shown the various possible concentrations of  $\text{Ca}^{+2}$  and  $\text{HCO}_3^{-1}$  that would be in equilibrium at a particular pH as shown by the following equations:

$$2) \quad K_{\text{sp}} = (\text{Ca}^{+2}) (\text{CO}_3^{-2}) = 10^{-8.22}$$

$$9) \quad (\text{CO}_3^{-2}) = (\text{HCO}_3^{-1}) \times \frac{K_2}{(\text{H}^{+1})}$$

hence

$$12) \quad K_{\text{sp}} = (\text{Ca}^{+2}) (\text{HCO}_3^{-1}) \frac{K_2}{(\text{H}^{+1})}$$

The  $\text{P}_{\text{CO}_2}$  curves are generated by use of equation 1, modified to exclude the carbonate contributed by the aquifer.  $\Delta \text{HCO}_3^{-1}$  is the amount of bicarbonate ion remaining after subtraction of the amount required to balance the calcium concentration in the water sample. Equation 13 is derived from equation 7, modified by terms from equation 10.

# Calculation of Carbon Dioxide Pressure

$$13) \quad (\Delta \text{HCO}_3^{-1}) = (\text{HCO}_3^{-1}) - \frac{(\text{Ca}^{+2})}{\left(1 + \frac{(\text{H}^{+1})}{K_2} + \frac{K_2}{(\text{H}^{+1})}\right)}$$

$$14) \quad P_{\text{CO}_2} = \frac{(\Delta \text{HCO}_3^{-1}) (\text{H}^{+1})}{K_1 K}$$

Water samples in which the plotted (equilibrium) pH differs from the analyzed pH require more careful evaluation. When the equilibrium pH is higher than the analyzed pH, the sample is undersaturated and the water is still capable of dissolving more of the aquifer. An equilibrium pH lower than the analyzed pH, indicates supersaturation, provided that there are not enough "foreign" ions in the solution to reduce the activity coefficients of the  $\text{Ca}^{+2}$  and  $\text{CO}_3^{-2}$  ions (generally, if more than 10 percent of the analysis consists of ions other than calcium and carbonate, this method will indicate a higher degree of saturation than actually exists). If the difference between the analyzed and the equilibrium pH is greater than  $\pm 0.5$  pH units, either the sample is quite undersaturated or a large percentage of foreign ions are present. Geologists with a modest background in chemistry would benefit from reading the short papers by Hem (3) and Back (1) and noting that with the addition of minor amounts of iron or sulphur the activity coefficients change rapidly.

## CONCLUSIONS

The graph permits rapid calculation of the partial pressure of carbon dioxide from standard ground-water analyses in limestone terranes. The simplicity of the method restricts its usefulness to waters containing almost entirely  $\text{Ca}^{+2}$  and  $\text{HCO}_3^{-1}$  ions. The value of this approach is that it is quick, easy, and may be used for field or laboratory analyses by geologists, geochemists, and chemists. It might be used when evaluating sites for the location of industrial buildings, which usually require some foundation support in bedrock, and in other investigations not directly related to standard water-resources studies. The method should aid the average geologist to better understand the role of ground water in chemical corrosion of limestone.

## ACKNOWLEDGEMENTS

This paper is the result of work by the Geological Survey of Alabama in cooperation with the Water Resources Research Institute at Auburn University and the Department of Geology at the University of Alabama.

LITERATURE CITED

1. Back, William. 1961. Calcium carbonate saturation in ground water, from routine analyses. U.S. Geol. Survey Water-Supply Paper 1535-D, 14 p.
2. Garrels, R. M. and C. L. Christ. 1965. Solutions, minerals, and equilibria. Harper and Row, New York.
3. Hem, J. D. 1961. Calculation and use of ion activity. U.S. Geol. Survey Water-Supply Paper 1535-C, 17 p.
4. Thrailkill, John. 1968. Chemical and hydrologic factors in the excavation of limestone caves. Geol. Soc. America Bull. 79: 19-45.

## Occurrence of *Clavagella armata*

### OCCURRENCE OF *CLAVAGELLA ARMATA* MORTON IN PERRY COUNTY, ALABAMA<sup>1</sup>

Michael W. Szabo  
Geological Survey of Alabama  
University, Alabama

#### INTRODUCTION

In the spring of 1968, 30 specimens of *Clavagella armata* Morton were collected from strata of the Tombigbee Sand Member of the Eutaw Formation of Late Cretaceous age in a road cut in the SE 1/4, NW 1/4, sec. 15, T. 18 N., R. 8 E., Perry County, Alabama (Fig. 1). The specimens occurred in a clayey sand layer underlain by an oyster reef and overlain by calcareous clay of the Mooreville Chalk (Fig. 2).

#### DISTRIBUTION

Woodward (10) reported that there are 14 fossil and 6 living species of *Clavagella* known. The living species are found at depths ranging from low tide to eleven fathoms (10) in the Mediterranean Sea, in the Indian Ocean around Australia, and in the Pacific Ocean around Australia and the Pacific Islands (5). The fossil specimens range in age from Cretaceous to Recent (6). Only one species has been reported in the United States, the remainder are found in France, Belgium, England, Egypt, Germany, and Italy (1).

*Clavagella armata*, the only species found in the United States, occurs in beds of Cretaceous age. It has been reported in the Navesink and Merchantville Formations in New Jersey (4) and Delaware (2), and the Ripley Formation in Alabama (3) and Tennessee (8) (Figs. 3 and 4).

This is the first report of this burrowing pelecypod from the Eutaw Formation in Alabama.

#### SYSTEMATIC DESCRIPTION

Phylum MOLLUSCA, Class PELECYPODA, Order EULAMELLIBRANCHIA, Superfamily CLAVAGELLACEA, Family CLAVAGELLADEA, Genus *CLAVAGELLA*.

Morton (3) named the species *C. armata* in 1834 from specimens found in friable arenaceous marl (Navesink Formation) of Cretaceous age near Arnetown, New Jersey. Weller (9) in 1907 described *C. armata* as follows:

"The dimensions of a complete internal cast of the shell, exclusive of the tube, are: Length, 14 millimeters; height, 8.5 millimeters; thickness, 7.5 millimeters. Shell subovate in outline; the beaks small, situated a little in front of the middle, slightly recurved. Anterior and posterior margins rather sharply rounded; ventral margin convex throughout. The anterior margin with several tubular spines. Valve rather

---

<sup>1</sup>Publication authorized by the State Geologist

strongly convex, the right one free, the left one attached to the tube. Surface of the cast smooth, the muscular impressions more or less strongly marked, sometimes scarcely distinguishable."

Specimens of *C. armata* found in Perry County were primarily internal molds composed of calcareous cemented sand. Fragments of original shell material were preserved on a few of the forms (Fig. 5). The bases of four tubular spines were preserved along the anterior margins of some of the specimens (Fig. 6).

These specimens (Fig. 7) conformed with those from the type locality as described and figured by Weller (9).

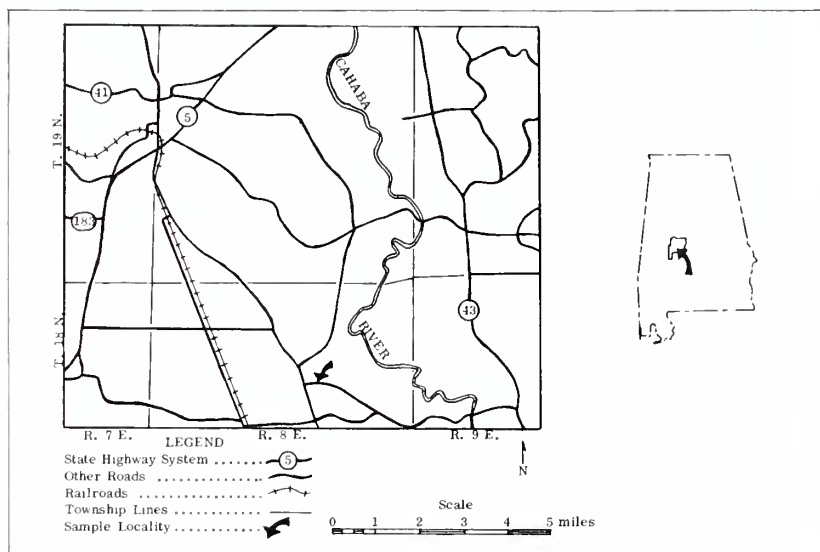


FIGURE 1. Map showing *Clavagella armata* locality in Perry County, Alabama. Arrow on Alabama outline map indicates region of the locality map.



# Occurrence of *Clavagella armata*

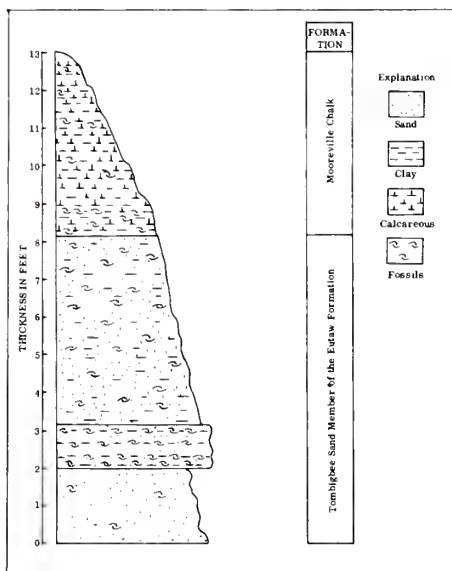


FIGURE 2. Section exposed along paved road in SE1/4, NW1/4. sec. 15, T. 18 N., R. 8 E.

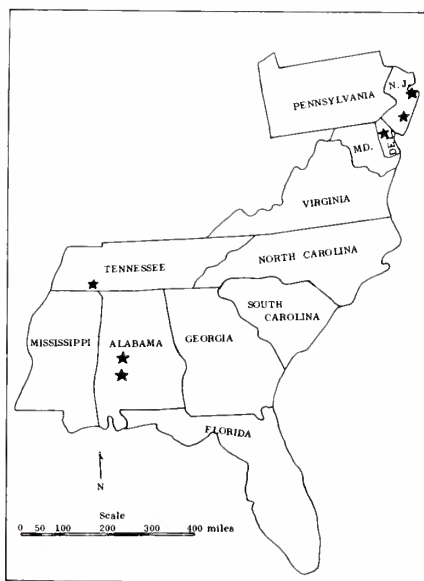


FIGURE 3. Distribution of *Clavagella armata*.

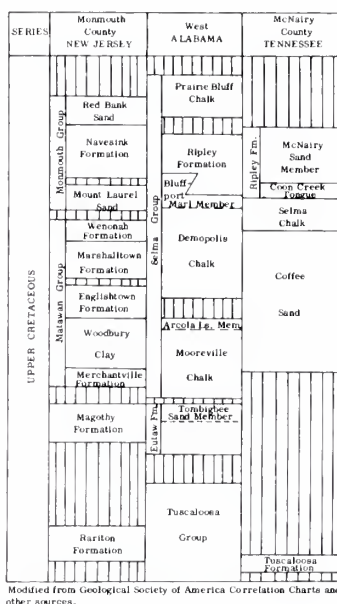


FIGURE 4. Generalized stratigraphic section of Upper Cretaceous rocks exposed in New Jersey, Alabama, and Tennessee.

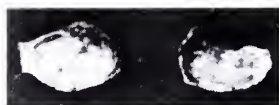


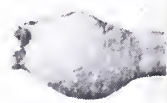
FIGURE 5.--Mold of *C. armata* from Perry County, Alabama with fragment of original shell material, 1x



FIGURE 6.--Anterior margin showing bases of four tubular spines. 1x



a



b

FIGURE 7a.--*Clavagella armata* from Perry County, Alabama. 1x

FIGURE 7b.--*Clavagella armata* from New Jersey as figured by Weller (1907, pl. 58).

LITERATURE CITED

1. Davies, A. M. 1935. Tertiary fauna. Nordeman Pub. Co., New York. Vol. 1, 406 p.
2. Groot, J. J., D. M. Organist, and H. G. Richards. 1954. Marine upper cretaceous formations of the Chesapeake and Delaware canals. Delaware Geol. Survey Bull. No. 3, 62 p.
3. Morton, S. G. 1834. Synopsis of the organic remains of the Cretaceous Group of the United States. Key and Biddle, Philadelphia. 88 p.
4. Richards, H. G. 1958. The cretaceous fossils of New Jersey. New Jersey Geol. Survey Bull. 61, pt. 1, 266 p.
5. Rogers, J. E. 1908. The shell book. Charles T. Branford Co., Boston. 503 p.
6. Shimer, H. W. and R. R. Shrock. 1944. Index fossils of North America. John Wiley and Sons, New York. 837 p.
7. Stephenson, L. W., P. B. King, W. H. Monroe, and R. W. Imlay. 1942. Correlation of the outcropping cretaceous formation of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas. Geol. Soc. Amer. Bull. 53: 435-448.
8. Wade, B. 1926. The fauna of the Ripley formation of Coon Creek, Tennessee. U.S. Geol. Survey Prof. Paper 137, 272 p.
9. Weller, S. 1907. Cretaceous paleontology of New Jersey. New Jersey Geol. Survey, Vol. 4, 853 p.
10. Woodward, S. P. 1871. Manual of the Mollusca: Crosby Lockwood and Sons, London. 541 p.

TRANSMISSION ELECTRON MICROSCOPE STUDY  
OF OSTRACODE CARAPACE ULTRASTRUCTURE

Ronald S. Taylor  
Department of Geology  
Auburn University, Auburn, Alabama

INTRODUCTION

Transmission electron microscopes have been used by paleontologists for over a decade. However, with few exceptions the fossils that have been examined in detail are those transparent to the electron beam. The small transparent microfossils that have been examined directly are largely spores, coccolithophorids, and diatoms.

For larger microfossils, such as ostracodes, conodonts, and Foraminifera, transparency is accomplished by making a thin-film replica of the surface of the specimen. Restrictions on the widespread use of replication techniques are their laboriousness and inapplicability to surfaces of greater than 50  $\mu$  relief. A two-stage or positive replication technique is generally preferred to a single-stage or negative replication technique because it does not necessitate destruction of the original specimen.

Transmission electron microscope studies of Foraminifera, using replication techniques, have been made by Jahn (4), Hay and Wright (2), and Krinsley and Bé (5) and of molluscan shell structures by Gregoire (1).

The purpose of this investigation was to determine if shell surfaces which appear smooth when viewed through a light optical microscope could be shown to possess a low relief ultrastructure when viewed through an electron optical system.

Fossil fresh-water ostracodes are significant subjects for this investigation because the determination of distinctive ultrastructure among these typically smooth-surfaced species would offer an additional character for taxonomic differentiation.

The selection criteria of (1) naturally smooth surfaces, (2) specimen sturdiness, and (3) preservation of original calcite microstructure were adequately met by specimens of two Eocene species of cypridacean ostracodes. The specimens came from two limestone samples of the Tipton Member of the Green River Formation in southwestern Wyoming. *Potamocypris williamsi* was originally described by Swain (6) from specimens collected in the Green River Formation of the Piceance and Uinta basins of Colorado and Utah. A *Candona* species similar to Swain's *Candona artesensis* is the other species selected for replication purposes.

MATERIALS AND METHODS

The replicating technique used was a simplified and considerably altered version of one described by Hyde and Krinsley (3). The ostracode specimens were washed in still water to eliminate as much loose debris

as possible. After cleaning and drying, specimens were immersed in acetone until further use. A short strip of faxfilm was taped onto a glass slide. The replicating process was initiated by placing a drop of acetone on the faxfilm and immediately transferring a specimen or cluster of specimens to the moistened area. A clean 000 sable-hair brush was used to transfer the specimens. While the faxfilm was soft, the specimens were partially embedded by pressing them with the corner of a glass slide. The degree of embedding was observed through a light optical microscope set at a low power; better replicas resulted when specimens were embedded only to a shallow depth. Additional specimens may be transferred to the faxfilm and embedded until space is no longer available for fresh applications of acetone. The specimens were extracted whole from the faxfilm without destruction of the replica, by applying gentle pressure with a dissecting needle. After removal of the specimens, the faxfilm was cleansed of clinging calcite by applications of a weak solution of HCl. The faxfilm was thoroughly rinsed in distilled water and dried. The acetate peel replica bore a negative relationship to the original specimen, with the peel representing a first stage replica. The film was again taped, replication side up, flush against a glass slide and placed in a vacuum evaporator where the replication surface was shadowed with chromium at an incident angle of about 45 degrees. Carbon was then vaporized directly down onto the film, thereby uniformly covering the chromium shadowed surface. After removing the faxfilm from the vacuum evaporator, the replicated areas were cut from the larger strip into 3 mm squares. The acetate was removed from the squares by floating them freely on a weak solution of acetone, the concentration of which was gradually increased until all the acetate was dissolved. This last step transformed the first stage replica into a second stage or positive replica. The specimen preparation was terminated when the floating replicas had been carefully manipulated onto circular grids. A wet replica was particularly susceptible to damage and should be dried for at least three minutes while held with forceps. The replica was then stored in a protective capsule prior to electron microscopic examination and photography.

The described technique permits resolution of structures larger than 150 Å. This is slightly better than the resolution presently obtainable with a scanning electron microscope.

## RESULTS AND DISCUSSION

The replicated surface of *Potamocypris williamsi* (Fig. 1) revealed a granulose ultrastructure. The individual granules were generally less than 1 μ in diameter. Granulose is defined as "an ornamentation of the valves consisting of more or less closely spaced minute protuberances, generally without distinct arrangement." The patternless areas may represent pores, warps and tears of the first stage acetate peel replica, or a masking cover of secondary calcite. A different specimen of *P. williamsi* (Fig. 2) revealed the same ultrastructure as before. The granulose pattern was present on most of the replicas of *P. williamsi*; in other instances the replicas were patternless, presumably due to faulty preparation. The topography in profile of the replicated surfaces is thought to be narrow depressions separating broad high areas (Fig. 3).

The replicated surface of the *Candona* specimens failed to show a



distinctive pattern. There was a suggestion of a rectangular pattern, the units of which were larger than the granules seen previously for *P. williamsi*. There are several possible explanations for the apparent lack of a characteristic surface topography: (1) perhaps *Candona* is truly devoid of ultrastructural relief; (2) the ultrastructure has been obliterated by abrasion; or (3) secondary calcite has had a masking effect.

#### ACKNOWLEDGMENTS

I am greatly indebted to Kansas University for use of its Phillips 100 Kv electron microscope and to Dr. M. P. Bauleke for technical advice.

#### LITERATURE CITED

1. Grégoire, C. 1957. Topography of the organic components in mother-of-pearl: Biophys. and Biochem. Cytology 3: 797-808.
2. Hay, W. W. and R. C. Wright. 1963. Some ultra structures of some selected foraminiferal tests. Micropaleontology 9: 171-195.
3. Hyde, P. and D. Krinsley. 1964. An improved technique for electron microscopic examination of Foraminifera. Micropaleontology 10: 491-493.
4. Jahn, B. 1953. Elektronenmikroskopische Untersuchungen an Foraminiferenschalen. Zeitschr. Wiss. Mikroskopie 61: 294-297.
5. Krinsley, D. and A. W. H. Bé. 1965. Electron microscopy of internal structures of Foraminifera. Handbook of Paleontological Techniques, pp. 335-344.
6. Swain, F. M. 1964. Early tertiary freshwater Ostracoda from Colorado, Nevada, and Utah and their stratigraphic distribution. J. Paleontology 38: 256-280.



FIGURE 1. Electron photomicrograph of the replicated surface of Potamocypris williamsi specimen A.

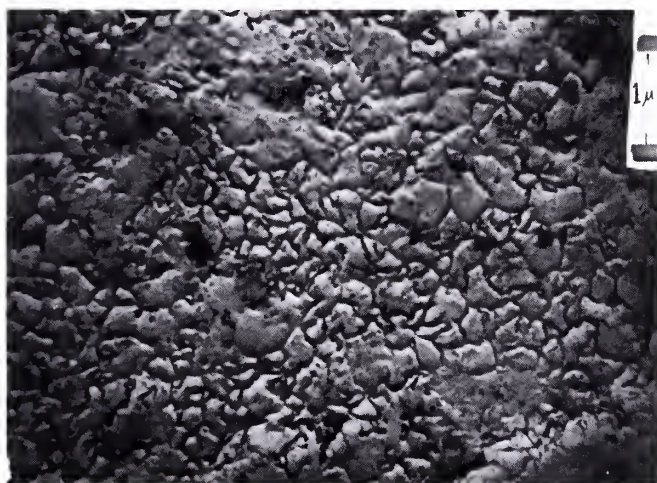


FIGURE 2. Electron photomicrograph of the replicated surface of P. williamsi specimen B.

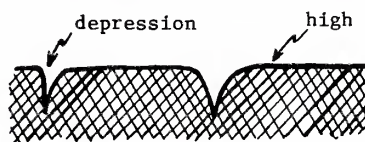


FIGURE 1. Profile of ostracode microtexture.

A BRIEF HISTORY OF BLAKELEY, BALDWIN COUNTY, ALABAMA

Thomas A. McMillan and Harold O. Beals  
Department of Forestry  
Auburn University, Auburn, Alabama

About 1813, Josiah Blakeley purchased some 600 acres of land from Dr. John Chastang on which to build a town bearing his name. This land, as shown on the land district maps of 1830 and 1837, lies at an angle across the usual rectangular system of surveying (22). In April or May of 1813, Josiah Blakeley brought James Magoffin, a surveyor, from St. Stevens to lay out his town. It was laid out in a regular manner with streets 99 feet wide running north and south and east and west. The streets were named Washington, Orleans, Robinson, Franklin, Warren, Greene, Wayne, Clinton, Baldwin, Handcock, Shelby, Clarke, and Blount, among others (8, 14, 18). Over 400 lots were sold, the first being a block of 10 to a Warren Ross Dodge for \$1000 (9). The town was incorporated under the name Blakeley on January 6, 1814, and later authorization was given for port facilities. The town plat was recorded in the Mobile Deed Book "A". However, in 1822 the plat was removed and has since disappeared (8, 21).

Josiah Blakeley died in 1815 and was thought to have been buried in the town cemetery (5) but no record of his grave was found in the 1920's when the cemetery was partially restored (4).

At its height, Blakeley rivaled Mobile both in size and port facilities, and fiercely competed with Mobile as the chief southern port (20). It boasted warehouses and cotton factories more numerous than Mobile, a newspaper, a hotel or two and even a steamboat company (2, 4, 10, 16, 17). In 1820, Blakeley was named the second county seat of Baldwin County and remained so until 1870 (3, 4).

Transportation to Blakeley was limited to a steamboat ferry which made regular runs between Blakeley and Mobile (17). Later a stagecoach route was established between Blakeley and Montgomery and between Blakeley and Mobile.

The local newspaper, *The Blakeley Sun*, was the fourth to be established in the state and published regularly semi-weekly for a time. It was a short lived enterprise and lasted only a year or so (6, 20). A few microfilm issues of *The Blakeley Sun* are located in the Archives of the Auburn University library.

Descriptions of the town vary greatly. According to Samuel Haines who was Blakeley's lawyer, writing in the *Port Folio* in October 1817, Blakeley was an "American Canaan" with abundant water supply, warm climate, spacious port facilities and apparently little short of paradise (1, 7). But to Adam Hodgson, an English Scholar, who traveled extensively through North America during the 1820's, it was "a real town of yesterday" with the stumps of trees standing in the streets. He also noted in his Journal, dated May 5, 1820, that he could find no Protestant church either in Blakeley or Mobile where "profaneness, licentiousness, and ferocity seemed to be characteristic of the place".

## Brief History of Blakeley

He noted, too, that "the ravages of the fever here last year were proportionately more severe than at any other place. In July the population was 1300; soon after the appearance of the fever in September, it was reduced by migrations to 500, of which number 274 died, including 115 inhabitants. I never left a place with more satisfaction (11)."

The fever undoubtedly was the cause of the demise of Blakeley as well as its citizens. Malaria and yellow fever caused many of the deaths as recorded on the tombstones in the Blakeley cemetery (4, 12, 20).

The town lasted until about 1830. According to Strickland's Directory (5), "After a vain struggle, Blakeley gave up and transferred its remains to Mobile, all save the tavern and the courts. Every quarter, down into the fifties, the court there opened, and the tavern awoke; but that was all that was left of Blakeley".

But this was not quite the end of Blakeley. During the Civil War, the site of Blakeley was made into a Confederate Fort to help protect Mobile, together with the assistance of Forts McDermott, Huger, Tracy, and Spanish Fort. A railroad was constructed between Blakeley and Pensacola and Blakeley was fortified with some three miles of earthworks. The garrison contained some 3500 men under the command of Brig. General St. John R. Liddell (3, 13, 19).

On Sunday, April 9th, 1865, Spanish Fort was evacuated and some 1400 Confederate troops led by Col. Lockett, made their way through the swamps and across the Old Military Bridge to Fort Blakeley, some five miles away (20). The assault on Blakeley took place late in the afternoon of April 9th, 1865, several hours after Lee had surrendered. Maps of the seige show extensive earthworks, minefields, and numerous installations of abatis fortifications (23, 24). The Union army under the command of General Canby with 25,000 men swept over the fort and the battle was over in less than an hour. More than 1,000 casualties were taken by the Confederates and about 3,000 surrendered (15, 19, 20).

Today little that is visible remains of Blakeley itself. The earthworks and fortifications are still there stretching some two miles in length and in much the same condition as they were 100 years ago. The cemetery is surrounded by an iron fence but most of the graves have been dug up by vandals looking for buried treasure as has most of the site of Blakeley itself. Adding to the lure of treasure are legends that the pirate, Lafitte, buried treasure under the giant oak tree standing near the ruined foundations of the old courthouse. Standing on the bank near the site of the old wharf, one can see the lights and smokestacks of Mobile, "the city Blakeley once sought to surpass."

## LITERATURE CITED

1. Alabama Historical Quarterly. 1941. Vol. 3: 74-77. State Dept. of Archives & History. Montgomery, Ala.
2. Brannon, Peter A. 1935. Old Blakeley. The Montgomery Advertiser, Montgomery, Ala., February 24.

3. Brewer, Willis. 1872. Alabama: Her history, resources, war record and public men from 1540 to 1872. Barrett & Brown, Printers, Montgomery, Ala.
4. Comings, L.,J. Newcomb and Martha M. Albers. 1928. A brief history of Baldwin County. Baldwin County Historical Society, Fairhope, Ala.
5. Craighead, Erwin. 1925. From Mobile's past. Powers Printing Co., Mobile, Ala.
6. Ellison, Rhoda C. 1954. Early Alabama publications. University of Alabama Press, University, Ala.
7. Haines, Samuel. 1817. Soil and climate of the American territories. The Port Folio, Philadelphia. October.
8. Hamilton, Peter J. 1910. Colonial Mobile. Houghton Mifflin Co., Boston & New York.
9. Hamilton, Peter J. 1898. Some southern Yankees. The Mobile Daily Register, Mobile, Ala. Dec. 11.
10. Hardy, John. 1879. Selma: her institutions and her men. Times Book & Job Office, Selma, Ala.
11. Hodgson, Adam. 1823. Remarks during a journey through North America in the years 1819, 1820, 1821. Samuel Whiting, New York.
12. Holt, David. 1928. The value of an historic past. A Brief History of Baldwin County. Baldwin County Historical Society, Fairhope, Ala.
13. Parker, Rita. 1897. On historic ground. The Mobile Daily Register, Mobile, Ala. September 12.
14. Pickett, Albert James. 1900. History of Alabama. Webb Book Co., Birmingham, Ala.
15. Smith, Sidney Adair and C. Carter Smith, Jr. 1964. Mobile 1861-1865. Wyvern Press of S.F.E. Inc., Chicago.
16. The Mobile Commercial Register. 1821. Mobile, Ala., Dec. 20.
17. The Mobile Commercial Register. 1822. Mobile, Ala., Feb. 17.
18. The Mobile Daily News. 1892. Mobile, Ala., May 31.
19. The war of the rebellion; a compilation of the official records of the Union and Confederate armies. Government Printing Office. Washington, D.C. 1901. Series I, Vol. 47 & 49. Series II, Vol. 8.
20. Transactions of the Alabama historical society, Vol. 3, 1897-1898. Alabama Historical Society, Tuscaloosa, Ala. 1904.
21. Toulmin's laws of Alabama. 1823. Ginn & Curtis, Cahawba, Ala.



## Brief History of Blakeley

### MAPS

22. Land district east of Pearl River (Date 1830) Township 3, Range 2 East. Dimensions 15 x 28 in. Also, Land District Southern Park of Alabama (Date 1837) Township 4, Range 1 & 2 East, Dimensions 15 x 28 in. Records of the Bureau of Land Management, Alabama Plat Book 38, Record Group 49. General Services Administration, National Archives and Records Service, Washington, D.C.
23. No. 2 siege operations at Spanish Fort, Mobile Bay. (Date: April 8 & 9, 1865) Records of Chief of Engineers, Record Group 77, Dr. 121, Sheet 16. Original dimensions 32½ x 30 in. General Services Administration, National Archives and Records Service, Washington, D.C.
24. Map of Blakeley and vicinity. (Date: April 9, 1865) Records of Chief of Engineers, Record Group 77, J34. Original Dimensions 14½ x 12½ in. General Services Administration, National Archives and Records Service, Washington, D.C.



## HISTORY TEACHING IN THE HIGH SCHOOLS

Andrew M. Weaver  
Department of Secondary Education  
Auburn University, Auburn, Alabama

### PROBLEMS AND TRENDS

Despite the many innovations in the social studies, one thing seems very clear. History teachers are for the most part still being bombarded with accusations that history is poorly taught in our high schools. Criticisms have been offered by college professors of history, the public, educators, and students. Some of the critics rarely, if ever, visit high school classrooms, and invariably this segment is the most severe in their criticisms.

This paper is concerned with some of the problems confronted by the high school teacher and makes an attempt to analyze these problems in some detail. Let it be clear in the beginning that in this country we are committed to an educational system which has as its goal the education of all children to their optimum level of ability. If one thinks of this goal for a moment it isn't difficult to see that the public schools are faced with a tremendous task. Many of the grandiose plans for improvement do not consider this reality.

Now to place a history classroom in the above setting we immediately see serious problems: children who do not want to learn, children who cannot learn, children who cannot read, children with serious mental and emotional problems. Frequently these children are placed together in one classroom to learn history; a situation unacceptable to many teachers. Not all classrooms are like this, but there are more than most individuals realize. History should serve unique purposes for each pupil as an individual.

One of the major problems confronting teachers and curriculum developers is the inability to reach complete agreement on just what history is and where it should be taught. This is not too surprising when one realizes that historians have not been able to agree among themselves on a definition of history. According to Haskins, a few historians avoid any definition, while others speak in very general terms. For one it is the knowledge of things said and done, while another calls it "the past of mankind," and a third asserts that "the only possible answer is that history is the study of all past human activities." Haskins (8) and many others contend that the period prior to the appearance of written records is prehistory and belongs within the domain of archeology and anthropology.

Edward Gibbon, in one of his more cynical moods (9), wrote "History is indeed little more than a register of crimes, follies, and misfortunes of mankind." Arthur Bestor (1) more precisely defined history as "the documented and interpreted record of past activities in every domain of human life."

If the definition of history is not enough to confuse the teacher and student of history, the proposed uses will. One of the views receiving

the greatest distribution among high school teachers today is the one expressed by Henry Steele Commager (4). There are many other excellent articles and books on this topic. As the position of history in the secondary curriculum is becoming more and more threatened by other social science disciplines the manuscripts on the topic are becoming more numerous.

Commager makes some rather interesting and to some people disturbing statements on this subject. Imagine the reaction of the social studies teacher to this passage, particularly if she has been expounding the "practical" uses of history.

Let us admit at once that in a practical way history has no use. Let us concede that it is not good for anything that can be weighed or measured or counted, that can be used as chemistry or accounting can be used. It will not save us from repeating the errors of the past; it will not solve problems; it will not show us how to win wars or, more important, how to avoid them. It will not provide us with scientific explanations of depressions or keys to prosperity, with scientific guides to nominations and elections, with scientific controls over great questions of national policy. It will not contribute in any overt way to progress (5).

To Commager history is useful in the sense that art is useful--or music or poetry or flowers; perhaps even in the sense that religion and philosophy are useful. He agrees with Thomas Macaulay (5) who observed, "the pleasure of history is analogous in many respects to that produced by foreign travel. The student is transported into a new state of society . . . His mind is enlarged by contemplating the wide diversities of laws, of morals, and of manners." Toynbee has observed that history can perhaps show us possibilities or even probabilities but never certainties (10).

With this background in mind, one should explore existing problems and current trends or developments as they relate to history teachers, organization of the subject, textbooks and other resources, and teaching strategies.

First, the high school history teacher is the most maligned of the teachers at the secondary level. Charges have been made with some justification, that history is the most poorly taught subject in the high schools. It is doubtful that this charge can be substantiated. Edwin Fenton (6), history professor and leader in the movement to improve history teaching, has suggested that "history may be more poorly taught than the other social sciences because it is so much more complicated. While the economist or political scientist can concentrate on a much narrower area, the historian must explore all of them to be able to examine entire societies in the past." History is a hard subject to teach by any teacher and especially by the poor teacher. Poor in this case may mean inadequate or improper academic preparation. On the other hand it may mean lack of enthusiasm or any number of other things. The point is that poor teaching in this case may require much time and effort to improve or like some poor students the condition may be incurable.

The history teacher is handicapped by the ridiculous amount of red tape and non-teaching assignments in the high schools. Fenton (7) cites one example that will illustrate how things can be done effectively and in another case how a teacher can become helplessly entangled in the high school bureaucracy.

The director of the Amherst program contacted two teachers in the same department. In two days one responded enthusiastically that she would participate in the project. From the other came no reply for six weeks, long after the material had been exhausted. A letter was then received from the curriculum supervisor in the superintendent's office saying that a letter had been passed on to him by the principal, who got it from the department head, who got it from the teacher; he had talked it over with the assistant superintendent, and the two of them had decided that such a request for cooperation ought rather to be addressed to the superintendent whose name was enthusiastically supplied.

One of the first things the history teacher must learn to do is find a way to circumvent poor administrative practices where such exists.

While on the subject of administrative decisions and administrators, it should be pointed out that much poor history teaching is taking place because the person assigned to teach this course is often lacking in preparation and often is quite well prepared in some other area. Other teachers in the school may have history majors and be assigned to teach English or math which they are certified to teach. Many young college graduates going out to teach are offered jobs in areas unrelated to their major or minor. Fortunately, many states are putting a stop to such helter-skelter assignments.

Not all teachers who are well qualified and properly assigned make good teachers. Some are too lazy to keep abreast of current scholarship, some are emotionally unstable, thus a very poor risk to have in the classroom, while still others lack enthusiasm and creativeness. A disturbingly large number fall in the above categories. There are, of course, various other reasons for poor history teaching. Not the least among these is the example of poor teaching by college and university history teachers.

The teacher is the key to history instruction. Nothing can replace the dynamic, enthusiastic teacher and most of the handicaps mentioned can be overcome by good teaching. For as Commager (5) writes:

.... No other subject can be relied upon more confidently to catch the imagination of the young. No other offers such continuous drama; no other presents such a spectacle of greatness. If there be any value in history, our first task must surely be to catch the interest of the young, to persuade them to read and to study history, to open up to them the inexhaustibly rich world of the past.

Commager (5) further reminds the teacher that:

## History Teaching in High Schools

High school students do not have to learn everything during these high school years, nor to solve all the problems. It is enough that they become familiar with the problems and with some of the ways of thinking about them. It is enough that they acquire a taste for the reading and study of history; a taste and a habit, so that they will turn to it again and again in the years ahead, not as a chore nor even as a duty - but as a delight.

This seems to be in agreement with many of the innovative programs stressing inquiry and discovery as the heart of the learning process.

Paul Ward (14), Executive Secretary of the American Historical Association, in speaking to a general session of the NCSS in 1966, urged history teachers to restore to history teaching more of the sense of urgent inquiry, with all this entails of selection and relevance and inspiration.

A similar statement by the well-known historian Arthur Bestor (1) further emphasizes the need for more emphasis on historical inquiry at the high school level. He wrote:

Vastly more important than discrete isolated facts are the techniques of inquiry that produced them and that will lead to even more significant findings in future, if (but only if) methods of thinking are stressed in the teaching of the subject. The distinctive way of thinking in history is the historical method of inquiry and this differs from the method of inquiry in economics.

These historians further contend that high school students should be exposed to theories of history such as those offered by Toynbee, Spengler, Beard, Turner, and others. The teacher who does this must have a vast amount of knowledge available.

The total picture is not as dismal as it appears at first. Perhaps the most promising of the developments is the NDEA summer institutes. This is true in spite of some very poorly organized and conducted institutes. In addition a limited number of world history teachers travel and study abroad each summer under sponsorship of the U. S. Office of Education. Various other federal programs especially Title III ESEA, have had an impact on history and other social studies programs.

There have been several projects, financed by the federal government or private foundations, that have as their specific aim improving instruction in history. Three of the most significant ones are the world history project at Northwestern University, the American history project at Amherst, and Carnegie-Mellon program.

All of these projects have had outstanding historians either directing the projects or on the staff. Some phase of the programs brings high school and college history teachers together to work on developing

the subject matter materials to be taught. Dozens of other projects on a smaller scale could be cited.

Textbooks have been a cause for concern in the past. Available textbooks have been largely rejected by the experimental programs. Instead other printed materials are being substituted. While textbooks have greatly improved in recent years, most authorities consider them inadequate--in some cases completely unacceptable. Too often history textbook publishers have been more concerned about the number of pages devoted to this or that pressure group and have thus in an effort to retain "balance" lost much of the historical significance of the data. Professor Ray Billington (3) and a group of historians found some cases of extreme bias in the treatment of national bias presented in British and U. S. textbooks on the American Revolution, War of 1812, and World War I. Admittedly some of the reviewers of this book have accused the authors of being biased.

One of the major weaknesses of the textbook is the sterile, anti-septic way topics have to be treated to satisfy all pressure groups. Some of this is brought on by the effort to cover so much material in one book.

What is to be the organization of history in the secondary schools? Here one finds considerable disagreement. More and more history courses are becoming cultural studies. This has given rise to a renewed interest in the cultural approach to the study of history. In some other cases American studies is a required course. Both of these approaches require history teachers to borrow from the other social sciences and humanities. Beard's "Seamless Webb" was similar to this (11).

These ideas are not all new. Some historians, notably James Harvey Robinson, soon after the turn of the century wrote extensively about the "new" history. This was, among other things, merely a plea for more than just political and military history. The Harvard Guide to American History puts it another way. The historian, it says, must lay heavy tribute on economics, political science, cultural anthropology, sociology, law, statistics, and psychology (1).

Joseph Strayer (13), former chairman of the History Department at Princeton, wrote:

Granting that history should be the core of social studies curriculum two things should be noted. First, history has a duty to include all the types of materials that will illustrate and lay a foundation for the work of the other social sciences. It should not be exclusively political history--which was a failing in the past; nor should it be exclusively economic history or cultural--which is a failing of some present courses.

Strayer warns, however, while history can do much, it cannot do everything.

The internal structure of the individual history course is being subjected to careful examination by historians interested in what is



going on at the high school level. Bestor (2) suggests that "in any course with a serious intellectual purpose, the organized intellectual structure of a discipline, and not its factual conclusions only, must be effectively communicated to the student." Unfortunately, this has probably not been consistently done at any level.

Pressure from other social sciences for a place in the secondary curriculum has caused some to advocate dropping one of the United States history courses offered at the eighth and eleventh grades. There is no trend in this direction, but historians are having to present an argument for their case. This demand from other social sciences can be expected to continue and grow in intensity as time goes on. The danger of losing one of the United States history courses is not over.

There is renewed activity in the teaching of history at the high school level. This activity is especially significant because it is coming to some extent, as one historian (12) put it, from "brethren back in the settlements"--the historians. Every history teacher needs to be cognizant of this activity and be willing to contribute his or her share whether as a high school teacher or college professor. History teaching of the future must be better than that being done today.

#### LITERATURE CITED

1. Bestor, Arthur. 1968. Historical scholarship in the schools. The Role of History in Today's Schools. Occasional Papers Number Ten. Council for Basic Education, Washington. p. 30.
2. Ibid., p. 33.
3. Billington, Ray Allen. 1966. History is a dangerous subject. Saturday Review of Literature, January 15, pp. 59-61; pp. 80-81.
4. Commager, Henry Steele. 1965. The nature and study of history. The Charles E. Merrill Social Science Seminar Series, ed. by Raymond H. Meussig and Vincent R. Rogers. Charles E. Merrill Books, Inc., Columbus, Ohio.
5. Commager, Henry Steele. 1965. Why history? American Education, June, 1965, pp. 26-29.
6. Fenton, Edwin. 1966. The new social studies in secondary schools: an inductive approach. Holt, Rinehart, Winston, New York. p. 433.
7. Ibid., p. 449.
8. Haskins, Ralph W. 1965. What is history? The Social Sciences: Foundations of the Social Studies. ed. John U. Michaelis, and A. Montgomery Johnson. Allyn and Bacon, Inc., Boston. p. 34.
9. Ibid., p. 25.
10. Ibid., p. 30.



11. Hunt, Erling M. 1965. Current efforts to revise history and social studies instruction in the schools. The Role of History in Today's Schools. Occasional Papers Number Ten. Council for Basic Education, Washington. pp. 1-12.
12. Sellers, Charles G. 1966. The role of the college historian. The Role of History in Today's Schools. Occasional Papers Number Ten. Council for Basic Education, Washington. p. 15.
13. Strayer, Joseph R. 1962. History, American council of learned society and national council for the social studies. The Social Studies and the Social Sciences. Harcourt, Brace and World, New York. pp. 24-25.
14. Ward, Paul L. 1967. Should history be cherished? Some doubts and affirmations. Social Education 33: 188-192.

## Permeability of Stainless Steel Screens

### EXPERIMENTAL DETERMINATION OF PERMEABILITY OF 100, 250 AND 400-MESH STAINLESS STEEL SCREENS

B. G. McKinney and T. J. Overcamp  
George C. Marshall Space Flight Center,  
Huntsville, Alabama.  
and  
Massachusetts Institute of Technology,  
Cambridge, Massachusetts.

#### INTRODUCTION

A common material used for heat pipe wicks is stainless steel screen. The wick is an important factor in the operation of the heat pipe. A wick that is properly designed will ensure that sufficient liquid is always available in the evaporator of the heat pipe so that the heat transferred will be a maximum.

The flow rate of the liquid in the wick is limited by the maximum driving force from the capillary pressure and by the pressure losses from viscous dissipation. The capillary pressure depends on the surface tension of the liquid and the pore size of the wick. The viscous losses depend on the viscosity of the liquid and the permeability of the wick. This report presents the measurement of permeability of three type 316 stainless steel screens that can be used to form wicks of heat pipes. The screens were 100-mesh of 0.0045-inch diameter wire, 250-mesh of 0.0016-inch diameter wire and 400-mesh of 0.0010-inch diameter wire.

Since the flow in most heat pipe wicks is usually laminar, Darcy's Law  $Q = KA/\mu \, dP/dz$  describes the flow. This law is valid for one-dimensional flow in porous media that is dominated by viscous effects. The permeability,  $K$ , is the constant that must be experimentally determined.

The experiment consists of measuring the flow rate through the porous media (stainless steel screen) over a range of pressure drops. With the flow rate,  $Q$ ; an area of porous media,  $A$ ; the viscosity,  $\mu$ ; and  $dP/dz$  known. Then, by rearranging Darcy's Law, the permeability,  $K$ , may be calculated.

#### MATERIALS AND METHODS

The system was composed of a supply of distilled water, the test section, and the instrumentation to measure the flow, pressure drop, and the temperature of the water. Figure 1 is a schematic of the test apparatus.

The test section was several turns of stainless steel screen wrapped on a stainless steel rod. This screen and rod were fitted into a section of 1.0-inch stainless steel tubing. Pressure taps, to which a mercury manometer could be attached, were located 8 inches apart on the tube. Figure 2 shows the test section and the dimensions used for testing the three stainless steel screens.

The supply of distilled water was contained in a 6-inch diameter

tank that had a nitrogen pressurization system. Valves and a filter for the water were also contained in the flow system.

The instrumentation consisted of a mercury manometer, a thermocouple, a graduated cylinder, and a stop watch.

One variable that was difficult to control was the tightness of the screen in the test section. The method used involved calculation of the length of screen required based on the thickness of the screen and the dimensions of the test section.

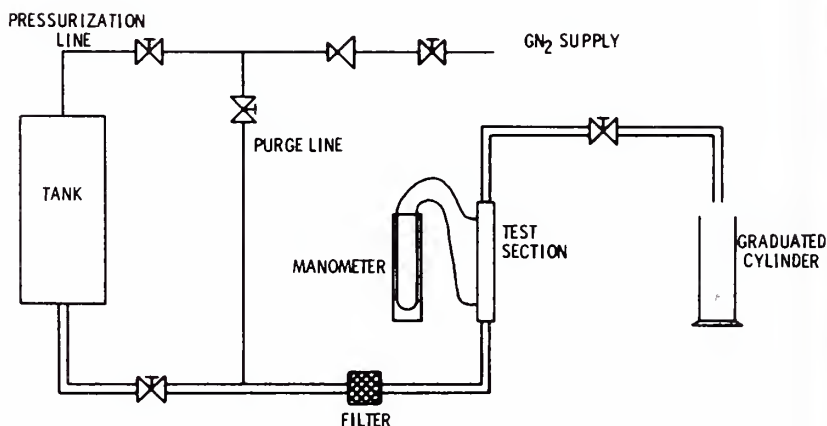


FIGURE 1. Test apparatus

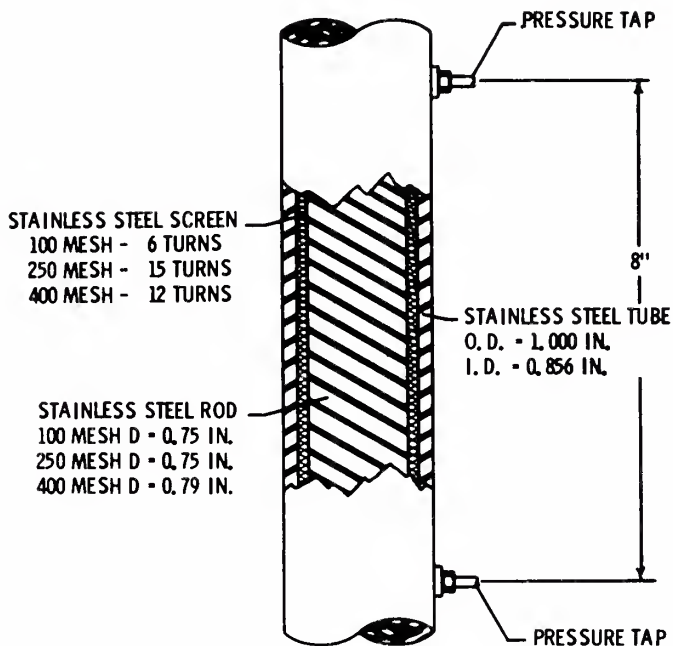


FIGURE 2. Test section

Major problems in measuring permeability are clogging of the porous media by foreign matter, air bubbles, and insuring that the test section is always full of water.

To prevent contamination by foreign matter, distilled water was used for the tests, and it was filtered before entering the test section. To prevent air bubbles, the test section was baked at 300 F for 1 hr to drive out water that trapped the air bubbles. The actual test time was kept to a minimum to prevent clogging. To insure that it is filled with water during the test, the test section was mounted vertically in the system.

Observing the preceding precautions, the tank was filled with distilled water and pressurized. From the tank the water flowed through a control valve, the filter, the test section, a control valve, and into the graduated cylinder.

Downstream of the test section, the temperature of the water was measured with a thermocouple, so that the viscosity,  $\mu$ , could be obtained from existing data. The pressure drop across an 8-inch portion of the test section was measured with a mercury manometer to determine  $dP/dz$ .

The water that flowed into the graduated cylinder was measured, and the time for such an amount to flow was measured with a stop watch. From this, the flow rate was determined.

### RESULTS

Three different screens were subjected to tests to determine the permeability. Data determined are presented in Figures 3, 4 and 5, and average values of permeability were  $2.67 \times 10^{-9} \text{ ft}^2$  for the 100-mesh screen,  $3.25 \times 10^{-10} \text{ ft}^2$  for the 250-mesh screen, and  $1.5 \times 10^{-10} \text{ ft}^2$  for the 400-mesh screen.

### CONCLUSIONS

The consistency of the data shows that if the procedure described herein is followed, the permeabilities determined are realistic. Also, compared to available data, the determined values for permeability are approximately correct.

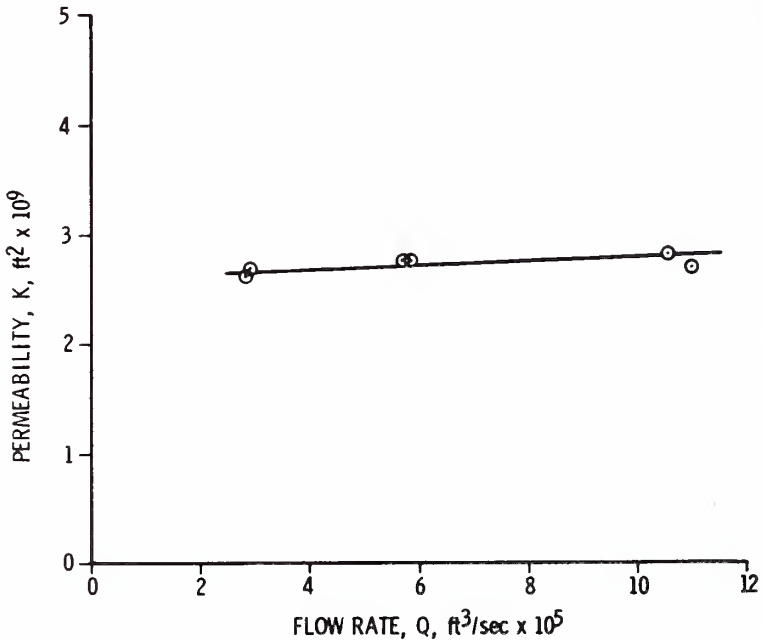


FIGURE 3. Permeability vs. flow rate for 100 mesh screen

# Permeability of Stainless Steel Screens

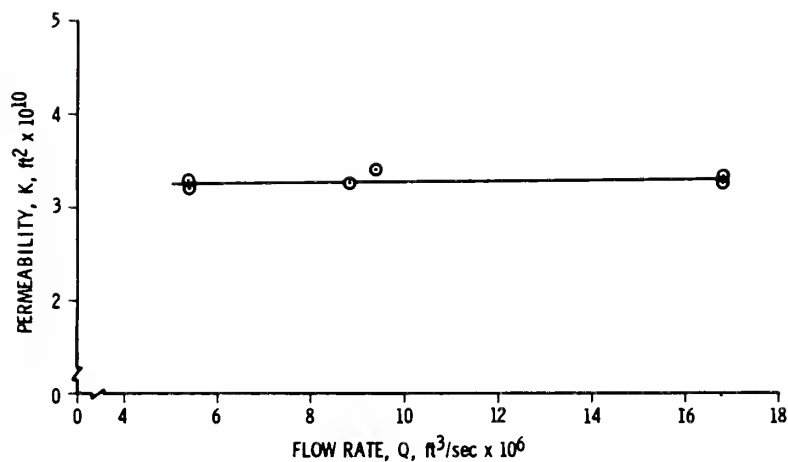


FIGURE 4. Permeability vs. flow rate for 250 mesh screen

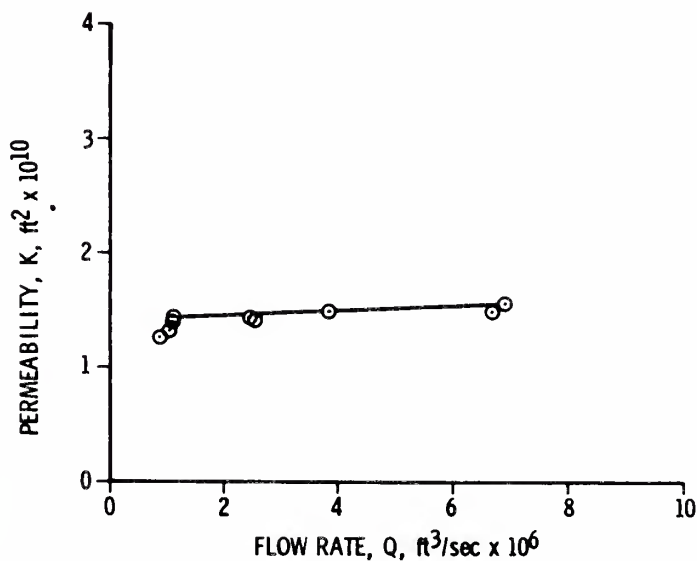


FIGURE 5. Permeability vs. flow rate for 400 mesh screen



AN EMPIRICAL ANALYSIS OF GROWTH AND DECLINE IN LEVELS  
OF RETAIL SALES IN ALABAMA AND THE SOUTHEAST

Joseph Barry Mason, Morris L. Mayer, & Charles Thomas Moore  
University of Alabama, University, Alabama

Even though aggregate levels of retail sales in most areas of the United States have increased since World War II, the growth rates for different geographic areas and for different categories of retail sales have varied considerably. These variations in levels of retail sales on a local and regional bases and by categories of goods cannot be meaningfully analyzed and weighed without a time, consistency, and movement frame. A shift analysis technique when applied to the data permits meaningful classification of growth rates in retail sales by focusing on two questions: (1) Does the region have a rapid or slow growth in terms of elements of retail sales?; and (2) Is the region increasing or decreasing its share of each of its growth categories relative to other areas? The analyses developed permit resolutions of problems related to time, consistency, and movement patterns.

*Shift Analysis*

The most significant application of the shift analysis technique (first used by Daniel Creamer in 1943) has been in the Office of Business Economics, U. S. Department of Commerce, which in the early 1960's performed an analysis of employment patterns in 3,100 local areas of the United States.<sup>1</sup> However, the technique has been applied in other areas--for example, in such diverse investigations as shifts in income differentials and shifts in military procurement. Simple algebraic formulations are applied to retail data for a region of the United States to divide changes in retail sales into three elements: national growth, retail establishments and sales mix, and regional share of specific classifications of retail sales.

National growth is derived by computing the national aggregate growth in retail sales over a specified time period for the nation and hypothesizing that, in theory, all regions should have at least as fast a growth rate in retail sales as that of the nation. Deviations from this norm represent relative net gains or losses in levels of retail sales for the region under analysis. At the retail sector level, these aggregate shifts are explained in two ways: (1) differential (competitive) shifts; and (2) proportional (compositional) shifts.

*Differential shifts* occur because the particular retail sector under analysis for the region has a different growth rate, either positive or negative, than for that category of retail sales on a national basis. *Proportional shifts* occur because the region has either a favorable or unfavorable distribution of fast growing retail sales segments relative to the nation. These shifts may be directly compared with shifts in other regions since they are computed from a common base of analysis--the national growth rate.

---

<sup>1</sup>L. D. Ashby. 1965. Growth patterns in employment by county, 1940-1950 and 1950-1960. U.S. Government Printing Office, Washington, D.C.

## Growth and Decline in Retail Sales

### *Analysis of Retail Sales Growth for Specific Segments of the Retail Structure Within Alabama and the Southeast*

This paper focuses on retail sales growth patterns for the Southeastern Region and for its component states--Kentucky, Tennessee, Alabama and Florida. Also a comparative analysis of the Birmingham SMSA and the Atlanta SMSA is presented.

An analysis of the retail sales data for the East South Central region is presented in Table 1. Column F depicts the change in retail sales between 1958 and 1963 and is calculated either by subtracting the figures in column A from column B or else by summing columns C, D, and E. Column G, the net relative change, represents the deviation from the national performance standard for each category of retail sales. It may be calculated by summing columns D and E or alternatively by subtracting figures in column C, the national growth component, from the corresponding figures in column F, the total change.

The East South Central region exceeded the national retail sales growth rate by more than \$370 million between 1958 and 1963. Tables 2, 3, 4, and 5 reveal that each of the four Southeastern states also exceeded the aggregate retail sales growth rate for the nation. Alabama exceeded the national growth rate by \$124 million and was second only to Tennessee which had an increase in retail sales of almost \$134 million beyond that which would have occurred if it had grown at the rate of the national average. As may be observed, the primary cause of this high positive aggregate growth rate in the region as a whole and in each of the four states was the growth in automobile sales. Again, Tennessee led the way with over \$144 million in automobile sales above the national growth average and was followed by Alabama with a growth figure above the national average for automobile sales of slightly more than \$127 million.

Three of the four states (Tennessee, Mississippi, and Alabama) had positive aggregate differential and proportional shifts for the 1958-1963 period. The positive aggregate proportional shift occurred primarily because automobile sales were a rapid growth category, i.e., the national sales rate for automobiles exceeded the retail growth rate for all national categories of retail sales combined, and these states had a favorable distribution of automobile sales outlets. The positive aggregate differential shift in all of the states except Kentucky again occurred primarily because of a positive differential shift in automobile sales which indicates that in the three states of Tennessee, Mississippi, and Alabama automobile sales expanded at a more rapid rate than was the case for automobile sales growth for the nation as a whole.

Net negative relative changes in retail sales for all four states were found for the categories of general merchandise, apparel and accessories, and furniture. Additionally, lumber sales experienced a net negative relative change in all of the states except Mississippi. The three categories of lumber, apparel and accessories, and furniture were the primary slow growth categories for the states in that the increases in these categories of sales for the 1958-1963 period were less

TABLE 1. Retail sales and components of retail sales growth for the east south central region (1958-1963).  
(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958	1963	National growth	Proportional shift	Differential shift		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
1.	Lumber, Bldg.Mat., Hardware Stores	743	898	163	-147	140	155	-7
2.	General Merchandise							
	Group Stores	1190	1383	261	174	-242	193	-68
3.	Food Stores	2444	3007	535	-144	174	563	30
4.	Automobile Dealers	1754	2541	384	356	47	787	403
5.	Gasoline Service Stations	782	1031	171	23	55	249	78
6.	Apparel, Accessory Stores	585	694	128	-60	41	109	-19
7.	Furniture, Home Furnishing Stores	483	562	105	-67	40	79	-27
8.	Eating, Drinking Places	501	610	110	-10	7	109	-3
9.	Drug, Proprietary Stores	345	438	76	10	8	93	18
10.	Other Retail Stores	815	962	178	-56	25	147	-31
11.	Non-Store Retailers	187	226	41	-14	12	39	-2
	TOTAL	9829	12351	2152	65	307	2523	372

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

Growth and Decline in Retail Sales

TABLE 2. Retail sales and components of retail sales growth for the state of Alabama (1958-1963)  
(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958	1963	National growth	Proportional shift	Differential shift		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
1.	Lumber, Bldg.Mat., Hardware Stores	18.1	21.3	39.6	-36.0	28.4	32.0	-7.6
2.	General Merchandise							
	Group Stores	33.0	38.3	72.2	48.5	-67.7	53.0	-19.2
3.	Food Stores	63.5	82.0	139.1	-37.5	83.2	184.8	45.7
4.	Automobile Dealers	45.1	67.7	98.8	91.5	35.6	225.9	127.1
5.	Gasoline Service							
	Stations	19.7	26.5	43.1	5.7	19.1	67.9	24.8
6.	Apparel, Accessory							
	Stores	17.0	18.8	37.2	-17.3	-1.9	18.0	-19.2
7.	Furniture, Home							
	Furnishing Stores	13.9	16.3	30.4	-19.2	12.8	24.0	-6.4
8.	Eating, Drinking							
	Places	11.7	14.5	25.6	-1.8	4.1	27.9	2.3
9.	Drug, Proprietary							
	Stores	8.9	11.0	19.5	2.5	-.9	21.1	1.6
10.	Other Retail							
	Stores	22.6	23.8	49.5	-15.6	-21.9	12.0	-37.5
11.	Non-Store							
	Retailers	3.2	5.1	7.0	-2.3	14.3	19.0	12.0
	TOTAL	256.7	325.3	562.0	18.5	105.1	685.6	123.6

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

TABLE 3. Retail sales and components of retail sales growth for the state of Kentucky (1958-1963)  
(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958	1963	National growth (C)	Proportional shift (D)	Differential shift (E)		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
1.	Lumber, Bldg.Mat., Hardware Stores	20.7	23.3	45.3	-41.2	21.9	26.0	-19.3
2.	General Merchandise Group Stores	28.6	33.7	62.6	42.0	-53.8	50.8	-11.8
3.	Food Stores	66.0	79.6	144.5	-38.9	30.4	136.0	-8.5
4.	Automobile Dealers	44.8	61.4	98.1	90.9	-22.8	166.2	68.1
5.	Gasoline Service Stations	19.5	26.4	42.7	5.7	20.5	68.9	26.2
6.	Apparel, Accessory Stores	14.8	16.6	32.4	-15.1	.7	18.0	-14.4
7.	Furniture, Home Furnishing Stores	12.3	13.5	26.9	-16.9	-1.9	11.9	-15.0
8.	Eating, Drinking Places	17.0	19.8	37.2	-2.6	-6.6	28.0	-9.2
9.	Drug, Proprietary Stores	9.4	11.9	20.6	2.6	1.8	25.0	4.4
10.	Other Retail Stores	21.4	25.7	46.9	-14.8	10.9	43.0	-3.9
11.	Non-Store Retailers	3.7	5.5	8.1	-2.7	12.6	18.0	9.9
TOTAL		258.2	317.4	565.3	9.0	13.7	591.8	26.5

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

TABLE 4. Retail sales and components of retail sales growth for the state of Tennessee (1958-1963)

(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958	1963	National growth	Proportional shift	Differential shift		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
1.	Lumber, Bldg.Mat., Hardware Stores	22.6	27.3	49.5	-44.9	42.5	47.1	-2.4
2.	General Merchandise	40.3	49.0	88.3	59.2	-60.9	86.6	-1.7
3.	Food Stores	79.1	92.9	173.2	-46.7	11.1	137.6	-35.6
4.	Automobile Dealers	57.7	84.8	126.4	117.1	27.1	270.6	144.2
5.	Gasoline Service Stations	26.1	33.6	57.2	7.6	10.8	75.6	18.4
6.	Apparel, Accessory Stores	17.1	20.8	37.4	-17.4	16.9	36.9	-5
7.	Furniture, Home Furnishing Stores	15.6	18.5	34.2	-21.5	16.4	29.1	-5.1
8.	Eating, Drinking Places	15.3	19.4	33.5	-2.3	9.8	41.0	7.5
9.	Drug, Proprietary Stores	10.9	14.3	23.9	3.1	7.1	10.2	34.1
10.	Other Retail Stores	25.0	31.4	54.8	-17.3	26.5	64.0	9.2
11.	Non-Store Retailers	10.1	8.9	22.1	-7.4	-26.8	-12.1	-34.2
	TOTAL	319.8	400.9	700.5	29.5	80.5	786.6	133.9

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.



TABLE 5. Retail sales and components of retail sales growth for the state of Mississippi (1958-1963)  
(\$100,000)

Line categories	Retail Sales*			Shift Analysis Components			Total change	Net relative change
	1958 (A)	1963 (B)	National growth (C)	Proportional shift (D)	Differential shift (E)	(F)		
1. Lumber, Bldg. Mat., Hardware Stores	12.9	17.9	28.3	-25.7	47.5	50.1	21.8	
2. General Merchandise								
Group Stores	17.2	17.3	37.7	25.3	-69.1	-6.1	-43.8	
Food Stores	35.8	46.2	78.4	-21.1	46.9	104.2	25.8	
Automobile Dealers	27.8	40.3	60.9	56.4	7.5	124.8	63.9	
Gasoline Service								
Stations	12.9	16.6	28.3	3.7	5.0	37.0	8.7	
Apparel, Accessory Stores	9.6	13.2	21.0	-9.8	24.8	36.0	15.0	
Furniture, Home Furnishing Stores	6.5	7.8	14.2	-8.9	7.7	13.0	-1.2	
Eating, Drinking Places	6.1	7.3	13.4	-9	-4	12.1	-1.3	
Drug, Proprietary Stores	5.3	6.5	11.6	1.5	-1.1	12.0	.4	
Other Retail Stores	12.4	15.2	27.2	-8.6	9.4	28.0	.8	
Non-Store Retailers	1.7	3.1	3.7	-1.2	1.5	4.0	.3	
TOTAL	148.2	191.4	324.7	10.7	79.7	415.1	90.4	

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

than the aggregate retail sales growth rate for the nation, even though the states as a whole experienced small positive aggregate proportional shifts--primarily because of automobile sales. On the other hand, these states experienced positive differential shifts for the categories of lumber, apparel and accessories, and furniture which indicate that even though these categories of retail sales failed to increase at the rate of the national aggregate sales growth, they did exceed the national growth rate for the three specific categories of sales under analysis.

The only negative differential shift for all four states was general merchandise which indicates that this category of retail sales failed to match the national rate of growth for general merchandise sales, even though the data do reveal that this category did exceed the national aggregate retail sales growth rate in each of the four states. No other discernible patterns for the remaining categories of retail sales in the four states are evident.

In summary, all four of the states in the East South Central region experienced positive aggregate differential and proportional shifts primarily because of the automobile sales category. However, the differential shift for each state was more pronounced than was the proportional shift.

Tables 6 and 7 reveal rather startling differences in aggregate levels of growth and in changes in the various categories of retail sales for the Atlanta and the Birmingham SMSA's. For example, the Atlanta SMSA exceeded the national aggregate retail sales growth rate for the 1953-1963 period by approximately \$120 million. In contrast, the Birmingham SMSA failed to meet the national retail sales growth rate for 1958-1963 by slightly more than \$35 million. However, both SMSA's did possess positive aggregate proportional shifts even though positive changes were relatively small. For example, 7 out of 11 categories of retail sales examined for each SMSA experienced negative proportional shifts. The aggregate positive proportional shift in each SMSA occurred primarily because of the rapid-growth nature of the general merchandise and automotive sales categories.

Significant differences in the two SMSA's were also evident when examining differential shifts for the 1958-1963 period. The Atlanta SMSA had a positive aggregate differential shift of approximately \$106 million as compared to a negative aggregate differential shift for the Birmingham SMSA of slightly more than \$43 million. Seven out of 11 categories of retail sales (lumber, building materials, and hardware stores; general merchandise stores; foodstores; apparel accessory stores; eating and drinking places; drug and proprietary stores; and other retail stores) in the Birmingham area experienced negative differential shifts as opposed to only two negative differential shifts for the Atlanta SMSA--lumber, building materials, and hardware stores; and non-store retailers.<sup>2</sup> The

---

<sup>2</sup>A more detailed analysis of 43 categories of retail sales in the Birmingham SMSA revealed that eleven categories of retail sales experienced absolute declines in sales levels between 1958 and 1963. See, Lyndon Dawson and J. Barry Mason. 1967. An analysis of selected retail sales trends in metropolitan Birmingham, Alabama: 1958-1963. *Ala. Acad. of Sci.* 38: 290-299. (October, 1967), pp. 290-299.

TABLE 6. Retail sales and components of retail sales growth for the Atlanta, Georgia  
S M S A (1958-1963)  
(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958	1963	National growth (C)	Proportional shift (D)	Differential shift (E)		
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
1.	Lumber, Bldg. Mat., Hardware Stores	72.5	69.7	15.8	-14.4	-4.4	-4.4	-18.8
2.	General Merchandise Group Stores	189.5	263.1	41.5	27.9	4.4	73.6	32.3
3.	Food Stores	256.0	333.4	56.1	-15.1	35.8	77.4	20.7
4.	Automobile Dealers	200.3	342.1	43.8	40.7	57.7	141.8	98.4
5.	Gasoline Service Stations	85.5	119.7	18.7	2.5	13.0	34.2	15.5
6.	Apparel, Accessory Stores	69.8	84.0	15.3	-7.1	5.8	14.2	-1.3
7.	Furniture, Home Furnishing Stores	47.3	59.6	10.4	-6.5	8.5	12.3	2.0
8.	Eating, Drinking Places	68.5	102.7	15.0	-1.0	20.3	34.2	19.3
9.	Drug, Proprietary Stores	40.7	58.1	8.9	1.1	7.4	17.4	8.5
10.	Other Retail Stores	99.6	128.8	21.8	-6.9	13.9	29.2	7.0
11.	Non-Store Retailers	99.7	57.7	21.8	-7.3	-56.4	-42.0	-63.7
	TOTAL	1229.4	1618.9	269.1	13.9	106.0	389.5	119.9

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

TABLE 7. Retail sales and components of retail sales growth for the Birmingham, Alabama  
MSA (1958-1963)

(\$100,000)

Line	Retail sales categories	Retail Sales*		Shift Analysis Components			Total change	Net relative change
		1958 (A)	1963 (B)	National growth (C)	Proportional shift (D)	Differential shift (E)	(F)	(G)
1.	Lumber, Bldg.Mat., Hardware Stores	32.3	29.1	7.1	-6.4	-3.9	-3.2	-10.3
2.	General Merchandise Group Stores	97.9	103.6	21.4	14.4	-30.0	5.7	-15.6
3.	Food Stores	156.3	178.0	34.2	-9.2	-3.1	21.7	-12.3
4.	Automobile Dealers	112.4	173.4	24.6	22.8	13.3	61.0	36.1
5.	Gasoline Service Stations	44.3	56.9	9.7	1.3	1.4	12.6	2.7
6.	Apparel, Accessory Stores	48.7	50.8	10.6	-5.0	-3.7	2.1	-8.7
7.	Furniture, Home Furnishing Stores	35.5	39.3	7.8	-4.9	1.0	3.8	-3.9
8.	Eating, Drinking Places	36.4	38.9	8.0	-5	-4.9	2.5	-5.4
9.	Drug, Proprietary Stores	22.6	26.5	4.9	.6	-1.7	3.9	-1.1
10.	Other Retail Stores	58.9	56.2	12.9	-4.1	-11.8	-2.7	-15.9
11.	Non-Store Retailers	14.1	16.2	3.1	-1.0	.1	2.1	-.9
	TOTAL	659.4	768.9	144.3	8.0	-43.3	109.5	-35.3

\*Source: U.S. Bureau of the Census, Census of Business, 1963, Retail Trade Summary Statistics.

most significant negative differential shift in Birmingham was for the general merchandise group of stores which experienced a negative differential shift of approximately \$30 million.

In comparing the two SMSA's with the East South Central region, it is evident that the Atlanta SMSA followed the general trend of the Southeast, while the Birmingham SMSA failed to keep pace with the region in the time period analyzed. Not only did the majority of its sales categories fail to keep pace with the national aggregate growth rate, they also failed to equal the national sales growth rate for each category of sales analyzed.

*A Note of Caution in Data Interpretation*

First, shift analysis is descriptive only; it does not explain the causes of growth or decline. Since the main value of the technique is in identifying basic trends, the investigator must bring additional resources of insight and analysis if he is to make fruitful generalizations concerning changes in levels of retail sales growth. However, the technique does have analytical utility in that it tends to focus on the underlying mechanisms of change.

A further point of caution is that the results forthcoming vary slightly with the degree of disaggregation; that is, the sum of either shift component for disaggregated data may not exactly equal the same shift component for the aggregated data, particularly when the analysis is performed for a small area.

If the necessary precautions are observed, this technique should function as a valuable aid to decision making in retail site selection studies, in estimating economic potential, in long-range planning, in forecasting levels of retail sales, in disaggregation and analysis of the growth elements of an area, and a host of related areas of analysis.

# Index

## INDEX

Abel Inversion, Computer Study of .....	197
Aflatoxin, Destruction in Corn by Gamma Radiation .....	146
Africa, Cultural Transformations as Seen Through Newspaper Letters .....	209
Ai, Palestine, Excavations .....	210
Air Pollution in Some Alabama Cities .....	166
Air Pollution in the Tuscaloosa Area .....	167
Allen, Lee N. ....	192
Alpha-Amino Acid Solutions, Surface Tension in .....	165
Ambrose, Richard .....	138
Amoebae, Preliminary Study of in Langan Pond, Mobile .....	137
Anode Current Distribution in Hydrogen Discharge .....	182
Anthropology Curriculum in Alabama Colleges and Universities, 1969 .....	211
Anthropometry, Graphic, in the Study of Body Build .....	193
Anxiety, Function as Related to Anomie in a Prison Population .....	195
Archer, J. L. ....	196
Arrays, Circular, Electronic Scanning .....	199
Ashton, W. J. ....	197
Askew, R. F. .... 171, 173, 178,	182
Atkins, A. J. ....	184
Attitude Assessment by Word Association .....	192
Bacteria, Heavy Metal Protection from UV-irradiation .....	140
Bailey, Paul C. ....	154
Bailey, Zeno E. .... 127,	219
Barfield, B. F. ....	198
Barr, Thomas A. ....	132
Bass, Striped, Distribution in Alabama .....	3
Bass, Striped, Production and Management in Alabama .....	7
Bauman, R. P. ....	171
Beals, Harold O. ....	242
Beckert, Heino .....	163
Bennett, L. Lee Jr. ....	157
Beschi, R. J. ....	128
Biogenesis: A New Theory .....	132
Biomedical Education, New Vistas: A Cooperative Approach to Continuing Education .....	149
Biomedical Education, New Vistas: A Symposium .....	149
Biomedical Education, New Vistas: Role of Educational Technology .....	150
Biomedical Education, New Vistas: Role of the Undergraduate College in Preprofessional Training .....	154
Blakeley, Alabama, A Brief History of .....	242
Blakeley, Alabama, History .....	242
Boltzman Equation, Solution to in The Scattering Approximation .....	176
Bond Financing in Alabama, Profile of Industrial Aid .....	183
Boozer, Reuben B. ....	128
Boron Trifluoride Dimethyl Ether Complex, Normal Coordinate Treatment .....	161



Boshell, B. R. ....	137
Bowden, Charles M. ....	66, 171
Bozeman, Nathan ....	129
Brain, Mammalian, Metabolic Adaptations ....	145
Branscomb, J. A. ....	11
Briscoe, Melbourne G. ....	205
Brown, R. M. ....	172
Bryant, Keith Jr. ....	105
Buck, W. J. ....	171
Budgeting in Local Government ....	30
Burning, Prescribed, in Longleaf Forests ....	169
Cadmium Sulfide Thin Films, Preparation by Vacuum Deposition ....	179
Cairns, E. J. ....	141
Camphor, Homoenolization ....	163
Cancer, Some Experimental Approaches to Control: A Symposium ....	157
Cancer, Some Experimental Approaches to Control: Comparative Metabolism of Cytosine Arabinoside ....	159
Cancer, Some Experimental Approaches to Control: Drug Studies Using Leukemia Cells ....	157
Cancer, Some Experimental Approaches to Control: Experimental Chemotherapy with Rodent Leukemia ....	159
Cancer, Some Experimental Approaches to Control: Mathematical Models for Understanding Chemotherapy Data ....	158
Cancer, Some Experimental Approaches to Control: Response of Solid Tumor to Chemotherapy ....	160
Cancer, Some Experimental Approaches to Control: Role of Biochemistry: Action of Some 6-Thiopurines ....	157
Carbon Particles in Flame, Optical Technique for Determining Size and Concentration ....	205
Carden, A. E. ....	198
Cardwell, Jerry D. ....	207
Carmichael, Emmett B. ....	129
Carroll, James C. ....	109
Casey, Albert E. ....	133
<i>Cercospora</i> , Application of Microhumidity Chamber for Inoculation of Peanut Leaves ....	130
Chaffin, Herbert S. Jr. ....	166
Chase, David W. ....	208
Chennareddy, Venkareddy ....	47
Clark, E. M. ....	130
Clark, Neil ....	185
Clark, R. C. ....	129
<i>Clavagella armata</i> , Occurrence in Alabama ....	233
Clere, Earl P. ....	103
Cline, George B. ....	131
Clonts, Jerry ....	138
CO <sub>2</sub> , Analysis of Limestone Ground Water ....	227
Cochis, Thomas ....	65, 138
Cole, F. E. ....	132
Computer Aid for Teaching Quantum Mechanics ....	181
Computer, Program for Finding Nonlinear Heat Transfer and Temperature Distribution ....	204

# Index

Computer, Programming in High School .....	37
Computer, Solution for Draining or Filling Cryogenic Fluids .....	207
Concepts, Pre-Literate and Alternative .....	210
Conrad, R. D. ....	173
Cooper, James W. ....	166
Cooper, John R. ....	179
Copper, Colorimetric Analysis for in Aluminum .....	11
Copping, Leonard G. ....	131
Couch, Richard .....	132
Coulometric and Voltammetric Processes, Reversible and Irreversible Reactions .....	164
Counter, Long, Design and Construction .....	181
Counter, Proportional, Light Pulse Spectrum .....	181
<i>Crassostrea virginica</i> , Uptake and Elimination of Chromium and Zinc .....	162
CSMP Applications to Chemical Problems .....	160
Curl, E. A. ....	133, 144
Curran, S. ....	198
Cycle-Counting, Improved Technique for Zone Refining Systems .....	121
Dagg, Martha .....	131
Dailey, George E. III .....	128
Daniel, Army Jr. ....	52, 173
Davis, D. E. ....	131
Davis, N. D. ....	146
Decker, S. K. ....	174
Dendy, J. S. ....	60
Design, A Neglected Technique in .....	201
Diener, U. L. ....	146
Dihedral Mirror, 'Curious Optical Theorem' .....	177
Dixon, Carl F. ....	147
Dixon, Donald W. ....	192
Douty, Helen I. ....	193
Downey, Eleanor L. ....	133
Dulmage, Elizabeth Ann .....	157
Durrell, W. S. ....	160
Dusi, Julian L. ....	223
Dusi, Rosemary T. ....	134
DWBA Polarization and Cross Section Calculations of d, n Reaction on Light Nuclei .....	180
Dykes, Donald J. ....	160
Eckert Robert J. Jr. ....	160
Economics, New, Failure in 1967? .....	105
Effigy Heads from Alabama, a Comparison .....	211
Ehrlich, John .....	132
<i>Eimeria stiedae</i> , Cytological and Cytochemical Studies on Sporozoites .....	134
Electron Spin Resonance Study of an Oriented Fluoro-radical .....	162
Electron Wave Functions and Band Gap Parameters in bcc Crystals .....	71
Endrin, Gas and Thinlayer Chromatographic Identification .....	147
Energy, Microwave, Production Using Solid State Devices .....	178
Environment, Notional Frontiers .....	103

Enzyme, Activity in Soil Colonized by <i>Rhizoctonia solani</i> or <i>Fusarium oxysporum</i> f. <i>vasinfectum</i> .....	145
Epoxides, Mixed Hydride Reductions .....	164
EPR and UPR, Frequency Dependence of Integrated Intensity .....	171
EPR and UPR Spectrum, Strain Broadening in .....	66
Essenwanger, Oskar M. ....	175
ESS, SCIS Materials, Preparing Teachers for Using .....	187
Estuarine Waters, Methods for Chemical Analysis .....	163
Fahey, M. D. ....	199, 202
Falgout, T. E. ....	199, 203
Fe (III) Complexes of EDTA Phenolic Analogs, Spectrophotometric Study .....	164
Fe <sup>57</sup> , Measurement of the Lifetime of 14.4 Ke V Level .....	179
Fenn, Hollis C. ....	115, 186, 187
Ferrocene, Experiments with .....	90
Fertilizer Compounds, Experimental .....	165
Filter, Tracking, Analysis and Design .....	206
<i>Flavobacterium</i> , Taxonomic Study of .....	136
Fletcher, Hewitt G., Jr. ....	161
Foramide, Reactions with Fenton's Reagent and Hydrogen Chloride...	93
Foster, Howard J. ....	71, 176
Frandsen, John C. ....	134
Franks, Don J. ....	135
Furman, W. L. ....	176
Gasses, Rarefied, Hypersonic Flow over .....	171
Gel Filtration of Small Molecules .....	165
Geography Curriculum in Alabama Junior Colleges .....	169
Gibson, F. P. ....	180
Gillaspie, Leon W. ....	209
Glaser, Rudolf F. ....	177
Glass, Sarah A. ....	209
Grackle, Observation's of Female Ethology during Nestling Development .....	127, 219
Graf, E. R. ....	132, 178, 198, 199, 201, 202
Griffith, Edward J. ....	115, 186
Gumprecht, Donald L. ....	121
Gunter, Shirley E. ....	136
Haas, Clyde M. ....	160, 161
Hackett, Berkley .....	167
Hackney, Peter A. ....	81
Hall, Leo M. ....	141, 145
Handy, Hayward O. ....	119
Hanke, C. E. ....	178
Hanlin, J. J. ....	178
Hannum, Wallace .....	37
Hansen, Asael T. ....	210
Harris, Norman .....	138
Hartman, R. L. ....	178
Hartwell, Michael .....	179
Harwell, K. E. ....	203
Hays, H. D. ....	167
H <sub>2</sub> CN - Chlorine Reaction, Study in a Flow Reactor .....	160
<i>Helicotylenchus dihystrera</i> , Effect on Yield of Soybeans .....	143

# Index

Herbicide, Atrazine - <i>Sclerotium rolfsii</i> Interaction as Influenced by C-N Ratio .....	144
Herbicide, Effect of EPTC on Growth and Enzymatic Activity of <i>Sclerotium rolfsii</i> .....	144
Herbicide, Effects of Atrazine on P32 Absorption and Translocation in Peas .....	143
Herbicides, Effect of s-triazines on Growth of Excised Roots and Callus Tissue .....	131
Herbicide, Effect of Trifluralin on Spore Production and Germination of <i>Fusarium oxysporum</i> f. <i>vasinfectum</i> .....	133
Heron, Population Density Fluctuations .....	223
Hershman, J. M. ....	137
Hill, J. L. ....	200
Hisey, Alan ....	165
History, Teaching in High Schools .....	246
Hobbes, Delores Ann .....	193
Hodge, Bernice K. ....	200
Holl, Herbert B. ....	177
Holmes, Jack D. L. ....	194
Hopkins, G. R. ....	200
Housing, Folk, Diffusion of European to America .....	212
Hung, Ching Tuen .....	136
Hypoglycemia, Tumor, Mechanism of Non-Pancreatic .....	137
Iodine, Changing Kinetics Due to Dietary Iodine Variations .....	128
Inositols, Chemical Studies Relative to Biosynthesis .....	161
IPS, Report on Implementation in Five Schools .....	186
Jackson, T. G. ....	161
James, E. James .....	164
Jasper, M. T. ....	202
Jencks, William P. ....	165
Johnson, P., Jr. ....	201
Johnson, Richard S. ....	187
Joines, Karen Rudolph .....	210
Joints, Durability of Glued Southern Pine .....	56
Jones, E. E. ....	137
Jupiter, Red Spot and Solar Activity .....	178
Juster, Robert J. ....	30
Kabana, R. Rodriguez .....	144
Kelly, H. D. ....	7
Kiely, Donald E. ....	161
Kispert, Lowell D. ....	162
Koch, Walter F. ....	168, 169
Kopfler, Frederick C. ....	162
Kreisberg, R. A. ....	137
Krypton Short-Arc, Relative Output .....	174
Kuenzel, H. ....	201
Ladd, Thomas G. ....	179
Lambert, James L. ....	163
Landers, Kenneth .....	65, 138
Lattice Spectra of Crystals, New Tables for Group Theory .....	171
Laser, Effects of N <sub>2</sub> -CO <sub>2</sub> on Water Hyacinth .....	132
Lemmon, Kenneth W. ....	195
Levedhal, B. H. ....	146
Lindsey, Donald W. ....	139
Lindsey, Raymond H. ....	148

Lithium Cleavages of 12-Alkylbenzo (a) phenothiazines .....	161
Little River Canyon, Floral Survey .....	138
Little River Canyon, Influence of Park Development on .....	138
Liu, C. K. ....	202
Lloyd, Harris H. ....	158
Loomis, J. M. III .....	202
Long, Pauline King .....	139
Loops, Two Feed, Investigation of Coupling Between .....	201
Lucas, Ann .....	113
Lyle, J. A. ....	130
Lynn, H. A. ....	140
Malatino, Raymond E. ....	202
Maple, William R. ....	169
Marsh, S. J. ....	182
Martin, B. W. ....	161
Martin, David W. ....	179
Martin, Elizabeth F. ....	188
Mason, Joseph Barry .....	258
Masses, Measurement with Cyclotron Resonance Method .....	182
May, Lloyd A. ....	163
Mayer, Morris L. ....	258
Mayo, Joseph G. ....	159
McCay, T. D. ....	203
McCrary, Joe .....	164
McCullough, J. F. ....	165
McDonald, P. F. ....	180
McDonald, Perry F. ....	66
McDowell, J. Hugh .....	162
McGrath, S. V. ....	203
McInnis, C. R. ....	173
McKinney, B. G. ....	253
McMahon, James .....	204
McManus, Samuel P. ....	90
McMillan, Thomas A. ....	242
McPherson, Milton .....	195
Measurement, Phase, At Microwave Frequencies .....	202
Meijer, Paul H. E. ....	71
Mellett, L. B. ....	159
Merritt, T. W. ....	141
Metabolic Profile, Age Changes in .....	133
Meyer, H. C. ....	180
MgO, Photochromaticity .....	173
Mice, Aggression in White Males .....	139
Mice, Analysis of Serum Proteins .....	135
Michel, John W. ....	181
Miller, S. Jones .....	141
Miller, T. G. ....	180, 183
Minutes, Annual Business Meeting .....	213
Missionaries and Anthropologists .....	209
Mitochondria, Effects of Magnesium on Banding Density .....	131
Mitochondria, Isolation and Characterization from Iguana Liver Cells .....	146
Mobile Home Industry, Northwest Alabama .....	170
Montgomery Papers .....	96
Moore, C. T. ....	258

# Index

Morris, S. R. ....	161
Morrison, Kathleen ....	142
Mössbauer Effect Spectrometer, Design and Performance .....	19
Mountcastle, W. R., Jr. ....	164
Negroes, Retail Store Patronage Among College Age .....	109
Nematodes, Ecology in a Small Fresh-Water Pond .....	141
Newberry, James .....	137
Norman, Joe R. ....	142
Norris, James E. ....	164
North, Charles Mallory .....	203
Oakley, Cary B., Jr. ....	211
Oaks, in Alabama .....	129
<i>Odocoileus virginianus</i> , Cementum Annuli versus Tooth-Wear Aging .....	128
Oligocene Valley, Middle, Sedimentary History in Nebraska .....	166
Optics, Charged-Particle, Introduction to Matrix Methods .....	181
Orbin, David P. ....	143
Ostracode Carapace Microtextures, Electron Microscope Study of .....	238
Overcamp, T. J. ....	253
Owen, Robert .....	143
Packard, John M. ....	149
Parasitoses Affecting Cofan Indians of Dureno, Ecuador .....	147
Passmore, Robert D. ....	181
Peeples, J. L. ....	144
Pell, K. M. ....	197
Pennington, L. ....	137
Perez, Cayetano and The American Occupation of Mobile .....	194
Peters, W. H. ....	204
Phosphatidyl-Ethanolamine, Separation into Molecular Species .....	142
3 Phosphoglycerate Kinase: Assay for and Inhibition by ADP .....	141
Photochromaticity, Radiation Induced Color Changes .....	178
Photoconductivity in Magnesium Oxide.....	182
Photodiodes for Measuring Temperature .....	173
Physics, Teaching, Computer Simulated Problems and Experiments .....	172
Pipes, Hinged Articulated, Stability Conveying a Fluid .....	202
Pittman, J. A., Jr. ....	128
Pitts, Gary .....	144
Plate, Elastic, Response on a Winkler Foundation to a Concentrated Load .....	203
Plates, Vibrations with Interior Line Fixities .....	203
Polymer Solution, Laboratory Experiment Concerning Viscosity and Molecular Weight .....	187
<i>Pratylenchus brachyurus</i> , Suitability of Soybean Host .....	139
Price, James W. ....	204
Prism, Zero Deviation Point .....	183
Profitability, Slave Operated Louisiana Sugar Plantations .....	184
Quarring, Industry in Central Alabama .....	208



Radiation, Equilibrium, from Hypervelocity Impact .....	203
Rat, Cotton, Quadrat and Biotelemetric Studies of .....	146
Redhorse, Study of Life History in Cahaba River .....	81
Regression Analysis of Off-Farm Migration in The Tennessee Valley.....	47
Republicanism in Jefferson County .....	192
Resonant Tube Partially Filled with Liquid, Observations on Behavior .....	198
Rhein, Walter F. ....	181
Richards, D. B. ....	56
Riggsby, Earnest D. ....	189
Robinson, C. Andrew Jr. ....	145
Robinson, E. L. ....	181
Rocket Motors, Effects of Retained Condensed Phases on Solid Propellant .....	200
Rodgers, Bertis N. ....	169
Roper, Richard A. ....	146
<i>Rotylenchulus reniformis</i> , Morphometric Variability .....	136
Rubin, Donald V. ....	205
Rushton, I. F. ....	19
Ryel, Richard .....	131
Ryel, R. R. ....	146
Sales, Retail, Growth and Decline in Alabama and Southeast .....	264
Sample, Selecting Rates .....	206
Sansing, G. A. ....	146
Science, Academic Failures, Helping Them to Succeed .....	115
Science, A Process Approach .....	40
Science, Cooperative College-School Program .....	176
Science, For All Children .....	188
Science, Interim Testing with Programmed Material in College .....	190
Science, Junior High Program: Status and Needs .....	184
Science, Physical, An Approach for Upward Bound Students .....	119
Science, Seek-it: The Systems Approach for Teacher Training .....	189
Science, Social, Scientific Measurement in: Present State and Direction .....	207
Science, Synergistics in Education .....	189
Science, Teaching Abroad, Opportunities and Values .....	113
Scintillators, Low Temperature Response .....	183
Searcy, Margaret Zehmer .....	211
Seed Germination, Laboratory Exercise .....	65
Self-Directed Learning Activities, Effects on Achievement and Retention .....	185
Seminar, Autolecture System .....	172
Sharry, John .....	150
Shell, William B. ....	189, 190
Sheridan, R. C. ....	93, 165
Sherman, Merle .....	170
Smith, Donald L. ....	181
Smith, Sandra G. ....	147
Sneed, Jo Ann .....	157

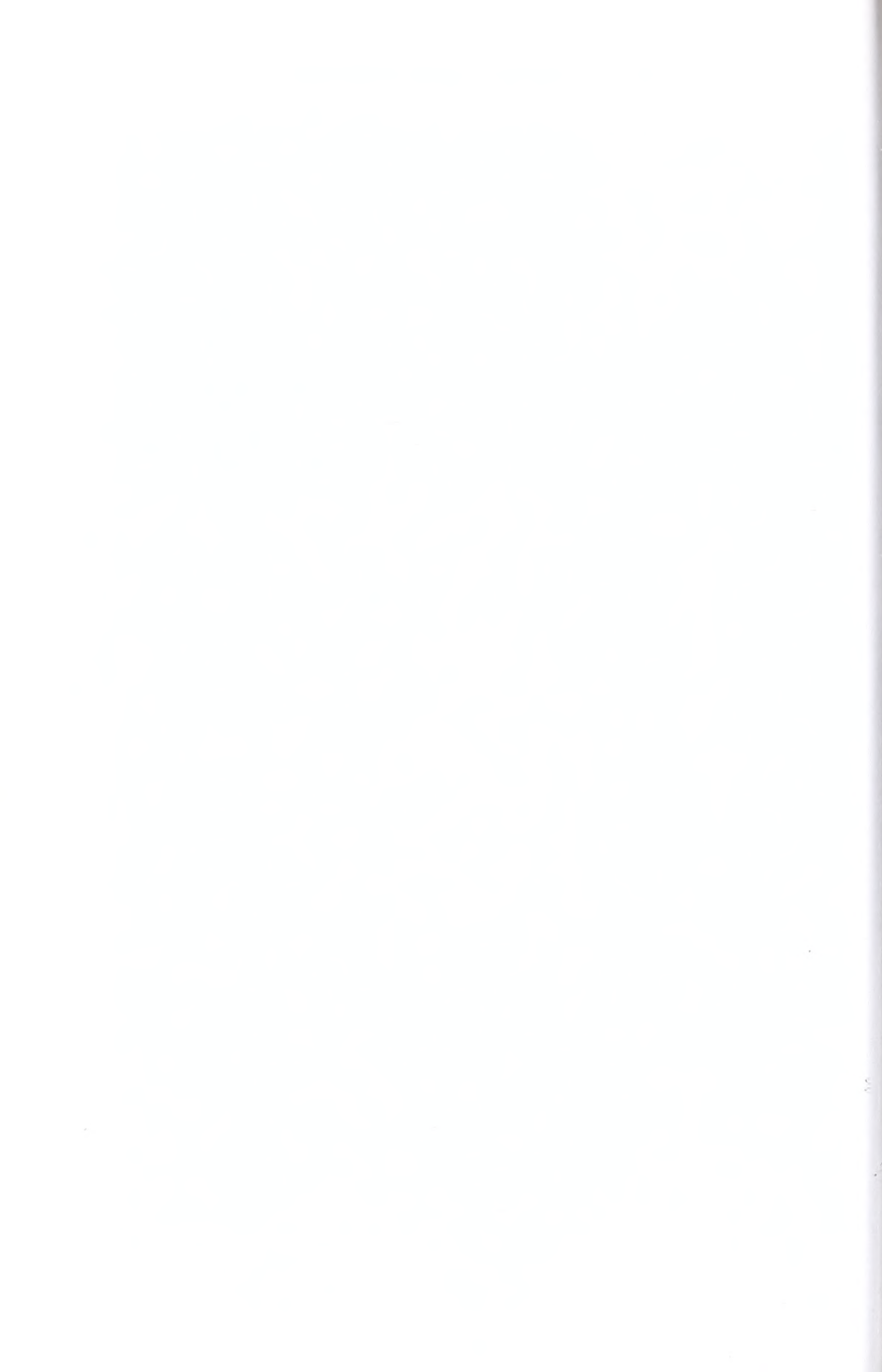
# Index

Somalia, Greater, The Problem of .....	167
Sonderegger, John L. ....	227
Sowell, Wendell L. ....	147
Space, Outer; Missions to Planets, Jovian Moons, and Halley's Comet .....	196
Space, Tape Recorder Applications .....	204
Sparkman, Brandon B. ....	187
Spencer, H. W. ....	182
Spencer, Sam L. ....	3, 81
Spenney, J. ....	137
Spitzer, Hugh L. ....	142
States Rights, Party Convention of 1948 .....	193
Steel, Stainless, Screens, Permeability of .....	259
Stewart, Dorothy Ann .....	182
Stokes Flow in a Porous Tube with Arbitrary Injection and Suction .....	202
Storms, Cyclonic, Satellite Study over The Southern Ocean .....	179
St. Pierre, Thomas .....	165
Stork, Wood, Status in Alabama .....	134
Stress Cracks, Thermal, Engineering in Small Circular Disks .....	198
Stress, Photo Analysis of Human Tooth .....	204
Supersonic Boundary Layer, Simplified Analysis .....	205
Szabo, Michael W. ....	233
Szillasy, Sandor .....	96
Tang, Anna .....	133
Taiwan, Agricultural Land Use Patterns Since 1945 .....	169
Tankersley, Bill C. ....	205
Tatum, Walter M. ....	81
Tax, Cotton, in Reconstruction .....	195
Taylor, Ronald S. ....	238
Teaching, New Approach to College .....	52
Teaching, Student Centered, A Second Year Look .....	173
Thiouracil, Participation in Anabolic Reactions Leading to RNA Synthesis .....	148
Thomas, Joseph C. ....	40
Thompson, Arthur A. ....	183
Tohver, Hanno T. ....	182
Truelove, B. ....	145
Tubes, Conveying, Stability with Periodic Perturbations .....	200
Turbulence and Wind Shear, Relationship .....	175
Two-Year Cycle, Effects on Extreme Winds and Temperature .....	182
<i>Tylenchorhynchus</i> sp, Biology on Soybean Plants .....	148
Ultrasonic Electron Nuclear Double Resonance Technique .....	180
Upconverter, 35 Gigahertz .....	198
Urban Areas, Political Geography .....	168
Vibrations of Stiffened Rectangular Plates Using a Separation Method .....	199
<i>Vicia</i> , Interspecific Compatibility .....	130
<i>Vicia</i> , Maintenance of an Albino Interspecific Hybrid .....	130
Vijil, Robert .....	206
Wakefeild, Z. T. ....	165
Weathers, Glenn D. ....	206

# Journal of the Alabama Academy of Science

Weaver, Andrew M. ....	246
Werkheiser, A. H. ....	183
Weller, Charles M. ....	187
Wen, Guang-Yeong ....	148
Whitten, David O. ....	184
Wilhide, W. D. ....	93
Wilkoff, Lee J. ....	157
Williams, Billy J. ....	123
Wilson, Eugene M. ....	170, 212
Wong, Mei Ying ....	148
Woodley, C. L. ....	165
Woods for Stropping Razors ....	60
<i>Woodwardia areolata</i> , Half-Fertile Half-Sterile Leaf ....	123
Yancey, Wayne ....	183
Yellen, Victor M. ....	37
Young, Carl T. K. ....	207
Yucatan, Soil and Shifting Agriculture ....	170















06076.1)A

# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

LIBRARY

JANUARY 1970  
APR 21 1970

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

VOLUME 41

NUMBER 1



THE JOURNAL  
OF THE  
ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 41

JANUARY, 1970

NUMBER 1

EDITOR, PRO TEM.

Robert T. Gudauskas  
Auburn University

ARCHIVIST

Clyde H. Cantrell  
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Ann Everett  
Crossville High  
School

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.



## CONTENTS

### ARTICLES

An Application of Factor Analysis to Socioeconomic Data in the Tennessee Valley Region Venkareddy Chennareddy and Wesley G. Smith . . . . .	4
Economic and Legal Aspects of the Single Tax Colony G. T. Stewart . . . . .	9
The Epistemological Significance of Verstehen Within the Framework of Management of Organizational Theory W. Jack Duncan . . . . .	17
Comparison of Soluble Proteins by Gel Electrophoresis of Selected <i>Chlamydomonas</i> Species Robert G. Tucker and James D. Yarbrough . . . . .	25
Spectroscopic Measurements of Velocities in Jets T. G. Roberts and W. L. Hales . . . . .	34
A Variational Procedure for Energy Eigenvalue Calculation of Non-Rigid Vibrators-Rotators Romas A. Shatas and John D. Stettler . . . . .	38
Gold Mining in Alabama in the Twentieth Century Kenneth R. Johnson . . . . .	45
Confederate Military Prisons: The First Permanent Prison in North Carolina Garry C. Mercer . . . . .	49
Recovery of a 13-Inch Sea Coast Mortar From Baldwin County, Alabama Thomas A. McMillan and Harold O. Beals . . . . .	56

# Socioeconomic Data In The Tennessee Valley

## AN APPLICATION OF FACTOR ANALYSIS TO SOCIOECONOMIC DATA IN THE TENNESSEE VALLEY REGION

Venkareddy Chennareddy and Wesley G. Smith

University of Wisconsin-Platteville  
and

Tennessee Valley Authority  
Muscle Shoals, Alabama

Factor analysis, a statistical tool for organization and resolution of a set of variables in terms of a small number of orthogonal "factors," has long been used to measure psychological theories of human ability and behavior (4). Lately it has been applied to socioeconomic data by Hagood (3) for delineation of counties, and by Stone (6) and Tintner (7), who applied it to economic variables. An application of factor analysis to municipal finance and measurement of urbanization and economic development was made by Wood (8) and Schnore (5), respectively. Adelman and Morris (1,2) factor-analyzed social and political variables and per-capita Gross National Product for 74 underdeveloped countries in one study and for fertility in another.

### METHODOLOGY

The objective of this study was to determine--through factor analysis--the relationship between socioeconomic variables and median income of rural farm families in the Tennessee Valley. The traditional multiple linear regression was not used because the highly intercorrelated (independent) variables usually create a problem of multicollinearity and fictitiously estimated parameters. After resolving a set of socioeconomic variables into orthogonal factors, a regression equation was fitted. Median income of rural farm families was the dependent variable and the derived factors were the independent variables. Variables were based on 1959 and 1960 county data for the 125 Tennessee Valley counties from the censuses of agriculture and population.

Variables included in the factor analysis and the dependent variable used in the regression analysis were:

- $Y_1$  Median income of rural farm families
- $X_1$  Percentage of all farm operators working off the farm 100 days or more
- $X_2$  Percentage of total male farm workers 14 years old or older working off the farm 100 days or more
- $X_3$  Percentage of total employment made up of farm people 14 years or older employed in manufacturing, wholesale and retail trade, and other industries
- $X_4$  Percentage of rural farm females 14 years old or older working in nonfarm jobs
- $X_5$  Percentage of all females 14 years old or older who are employed

- $X_6$  Percentage of adult farm population with eight or more years of schooling
- $X_7$  Average value of land and buildings per farm
- $X_8$  Percentage of all males 14 years or older who are employed
- $X_9$  Manufacturing wages per year
- $X_{10}$  Level of employment in manufacturing, coded as follows:

<u>Number of employees</u>	<u>Level</u>
0 - 999	1
1,000 - 2,999	2
3,000 - 4,999	3
5,000 and over	4

- $X_{11}$  Percentage of population who are Negroes

#### EMPIRICAL RESULTS

Table 1 summarizes results of the factor analysis, which is presented as a matrix of common factor coefficients, or "factor loadings." Each factor loading ( $a_{ij}$ ) gives the weight of factor  $F_j$  in explaining the socioeconomic variable  $X_i$ . Factor loadings indicate the strength of linear relationship between each factor and the observed variables.

The last column in Table 1 gives the sum of the squared factor loadings for each variable or its communality ( $h^2$ ). The communality indicates the proportion of total unit variance explained by all common factors taken together. For example, the communality for the variable  $X_1$  is:

$$(0.8223)^2 + (0.1052)^2 + (0.3125)^2 + (-0.1339)^2 = 0.8028.$$

This means that about 80 percent of the variation in the percentage of farm operators working off the farm 100 days or more was accounted for by the four common factors derived from the 11 socioeconomic variables. Although median income was not included in the factor analysis, the correlation between median income and factors 1, 2, 3, and 4 was computed and given in Table 1. Seventy-three percent of the variation in median income was explained by the four factors extracted from the 11 socioeconomic variables.

The factor loadings in Table 1 also provide a clue as to which set of variables belonged to each factor. Each variable was allocated to that factor which had the highest factor loading. In Table 1, variables for which factor loadings were highest in factors 1, 2, 3, and 4 were boxed, respectively. The derived factors were identified as:

#### Factor 1

Factor 1 provides a general index of off-farm employment of farm people. The three variables with the highest loadings were  $X_1$ , percentage

# Socioeconomic Data In The Tennessee Valley

TABLE 1. Rotated Factor Matrix for Median Income of Farm Families and Eleven Socioeconomic Variables.<sup>a</sup>

Variable	Rotated Factor Loadings <sup>b</sup>				
	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	$h_i^2(R^2)$
Y <sub>1</sub>	0.4529	0.3283	0.6394	-0.0991	0.7316
X <sub>1</sub>	0.8223	0.1052	0.3125	-0.1339	0.8028
X <sub>2</sub>	0.9334	-0.1113	0.1207	-0.0904	0.9064
X <sub>3</sub>	0.8986	0.0824	0.1495	-0.0417	0.8384
X <sub>4</sub>	0.0943	0.9680	0.0570	0.0583	0.9526
X <sub>5</sub>	0.0094	0.9624	0.0795	0.0431	0.9345
X <sub>6</sub>	-0.1186	0.5616	0.4288	-0.0262	0.5140
X <sub>7</sub>	0.0927	0.2188	0.7136	-0.1165	0.5793
X <sub>8</sub>	-0.5217	0.3926	0.5455	0.0088	0.7240
X <sub>9</sub>	0.2783	-0.1095	0.7924	0.1008	0.7275
X <sub>10</sub>	0.2920	0.1660	0.7334	0.1213	0.6654
X <sub>11</sub>	-0.1688	0.0674	0.0512	0.9625	0.9621

<sup>a</sup>Boxes indicate the factor to which each variable has been assigned.

<sup>b</sup>The rotation of the factor matrix is performed by varimax system.

of farm operators working off the farm 100 days or more; X<sub>2</sub>, percentage of employed farm males aged 14 or over working off the farm 100 days or more; and X<sub>3</sub>, percentage of farm population over 14 years of age employed in manufacturing, wholesale and retail trade, and other industries. The factor loading for X<sub>1</sub> was 0.8223, indicating a high positive correlation with factor 1. Since median income was also positively correlated with factor 1, an increase or decrease in the percentage of farm operators working off-farm 100 days or more causes a corresponding increase or decrease in the median income. X<sub>2</sub> and X<sub>3</sub> were also positively correlated with factor 1; hence, increases or decreases in X<sub>2</sub> and/or X<sub>3</sub> cause increases or decreases in median income, respectively. The factor loadings for X<sub>2</sub> and X<sub>3</sub> were 0.9334 and 0.8986. As expected, results support the consensus that off-farm employment is positively correlated with median income of rural farm families.

## Factor 2

In factor 2, variables with the highest factor loadings were those associated with employment of females (X<sub>4</sub> and X<sub>5</sub>). The variable with the next highest was level of education (X<sub>6</sub>). Each of these was positively

correlated with factor 2. Factor 2 was also positively correlated with median income of rural farm families. Therefore, an increase in any one of these three variables will increase median income. In factor 2, the factor loadings for  $X_4$  (percentage of rural farm females working in nonfarm jobs) and for  $X_5$  (percentage of employed adult females) were 0.9680 and 0.9624, respectively. The factor loading for  $X_6$  (percentage of adult farm population with eight or more years of schooling) was 0.5616. This means that only about 32 percent of the variation in factor 2 is explained by level of education. The positive relationship between median income and level of education indicates that the higher the educational level, the higher the median income of rural farm families because of improved management, adoption of improved technology, and access to up-to-date scientific information in farming. It also leads to improved incomes and opportunities for nonfarm employment because of better skills and training.

### Factor 3

Factor 3 provides an index of earning capacity of farm workers. The dominant variables with the highest factor loadings were  $X_7$ , average value of land and buildings per farm;  $X_8$ , percentage of employed adult males;  $X_9$ , manufacturing wages per worker per year; and  $X_{10}$ , employment level in manufacturing. Variables  $X_7$  and  $X_8$  together provided a general index of farm earnings. Variables  $X_9$  and  $X_{10}$  provided a rough composite index of level of earnings of farm people from nonfarm sources. These combined indexes provided an index of level of earnings per farm worker from both farm and nonfarm sources. About 21 percent of the total variation of the 11 socioeconomic variables under study, and about 41 percent of the variation in median income, were accounted for by this factor. The relationships between these four variables and factor 3 were positive. In general, an increase in one or more of the variables included in factor 3 would increase median income. The correlation coefficient between factor 3 and median income of rural farm families was 0.6394. Of the four variables, level of wages in manufacturing, which has a factor loading of 0.7924, seemed to be dominant. Next in importance was level of employment in manufacturing, with a factor loading of 0.7334. As the index for employment in manufacturing increases, farm workers have a greater chance of obtaining part-or full-time nonfarm employment. The factor loading for  $X_7$  was 0.7136, indicating that generally the higher the average value of land and buildings per farm, the higher the median income of rural farm families.

### Factor 4

The only variable contributing to factor 4 was  $X_{11}$ , percentage of population who are Negroes, which had a factor loading of 0.9625. Factor 4 and  $X_{11}$  were positively correlated, whereas median income and factor 4 were negatively correlated. The correlation coefficient between  $X_{11}$  and median income was -0.0991. This would imply that the higher the percentage of Negroes, the lower the median income of all rural families. Negroes generally obtain lower wages and have fewer full-time employment opportunities in both farm and nonfarm sectors. They usually own little land and have fewer buildings per farm. The generally lower income per Negro family also can be attributed to fewer years of schooling, which inhibits them from competing for higher paying, part-time or full-time nonfarm jobs.

# Socioeconomic Data In The Tennessee Valley

## RELATIONSHIP BETWEEN MEDIAN INCOME AND FACTORS

To determine the relationship between median income and the four factors derived in this study, a regression equation of the form:

$$Y = b_0 + b_1F_1 + b_2F_2 + b_3F_3 + b_4F_4 + e$$

was fitted, where Y is the median income of rural farm families;  $b_0$ ,  $b_1$ ,  $b_2$ ,  $b_3$ , and  $b_4$  are regression coefficients;  $F_1$ ,  $F_2$ ,  $F_3$ , and  $F_4$  are the factors (composite variables); and e is the random error. Results are shown below.

	Constant	$F_1$	$F_2$	$F_3$	$F_4$
Regression coefficient	2455.06**	263.99**	191.37**	372.73**	-57.76*
Standard error	27.46	27.57	27.57	27.57	27.57

\*\*Significant at the 1% level

\*Significant at the 5% level

Coefficient of multiple determination ( $R^2$ ) = 0.7316

The four factors explain about 73 percent of the intercounty variation in median incomes in the Tennessee Valley region.

The regression coefficient for factor 1 indicates that a 1-percent increase in the percentage of off-farm employment of rural farm males will increase median income of rural farm families in the Tennessee Valley by about \$265 (the exact coefficient is 263.99). The coefficient for factor 2 shows that if the total employment of females in either or both the farm or nonfarm sectors is increased by 1 percent, median income will rise by about \$190. For factor 3, a 1-percent increase in the earning capacity of farm workers will increase median income of rural farm families by roughly \$375. The negative coefficient for factor 4 implies that a 1-percent increase in the percentage of Negroes will decrease median incomes of rural farm families by approximately \$60. This is consistent with reasons mentioned in the previous section.

## CONCLUSIONS

The use of factor analysis allowed highly intercorrelated (independent) variables to be examined to determine their effect on median rural farm family incomes. Except for the race variable, each variable included in the analysis had a positive effect on income. Results are consistent with those expected for a region such as the Tennessee Valley, where less than 15 percent of all farms consisted of 180 acres or more in 1959 and where less than 2 percent had sales of \$10,000 or more. Under such conditions, nonfarm employment becomes an important source of income for most farm families. (In 1964, 58 percent of all farm families in the Valley reported income from wages and salaries in addition to income from farming.<sup>1</sup>)

<sup>1</sup>1964 U. S. Census of Agriculture, Preliminary Reports.



An increase in the combined index of the level of employment in both farming and nonfarm jobs (factor 3) had the largest effect on family income, which increased by about \$375 per year for each 1-percent increase in the earning capacity of farm workers. A 1-percent increase in off-farm employment of farm males is estimated to increase income by \$265, while a similar increase in employment of farm females is estimated to increase income by \$190 per year.

Although a negative relationship was found between the percentage of population who are Negroes and the level of median farm family income, the correlation coefficient was extremely small, indicating that very little of the total variation was explained by the race variable. This is also consistent with expectations, since less than 5 percent of the total 1960 population in any Tennessee Valley county consisted of Negroes.

#### LITERATURE CITED

1. Adelman, Irma and Cynthia Taft Morris. 1965. A factor analysis of the interrelationship between social and political variables and per capita gross national product. *Quarterly Journal of Economics* LXXIX: November.
2. \_\_\_\_\_. 1966. A quantitative study of social and political determination of fertility. *Economic Development and Cultural Change* XIV: January.
3. Hagood, M. J., N. Danilevsky, and C. O. Beum. 1941. An examination of the use of factor analysis in the problem of subregional delineation. *Rural Sociology* 6:216-233.
4. Harman, Harvey H. 1960. *The modern factor analysis*. The University of Chicago Press.
5. Schnore, Leo F. 1961. The statistical measurement of urbanization and economic development. *Land Economics* XXXVII: 229-245.
6. Stone, R. 1947. On the interdependence of blocks of transactions. *J. Royal Statistical Soc.* 8:1. supplement.
7. Tintner, Gerhard. 1954. *Econometrics*. John Wiley & Sons, Inc., New York.
8. Wood, Robert C. 1961. *1400 governments*. Harvard University Press. Cambridge, Mass.

## Aspects of Single Tax Colony

### ECONOMIC AND LEGAL ASPECTS OF THE SINGLE TAX COLONY

G. T. Stewart  
Troy State University  
Troy, Alabama

During the late 1800's, Henry George enlisted many ardent supporters at home and abroad for his single tax doctrine. His followers succeeded in starting many single tax colonies in the U.S.A. and abroad (2). Although several single tax colonies are still in existence, the oldest and largest one in the United States is located in Fairhope, Alabama, some 25 miles east of Mobile.

The idea behind Henry George's single tax was fairly simple. He believed that all taxes except on land values tended to discourage productive effort by decreasing the rewards going to labor and capital. Thus, he favored the abolition of all taxes except those on land values. Henry George also believed that a tax on land value would make land available for use and thus discourage speculation in land. Those withholding land from use would be forced through taxation to either make production use of land themselves or to allow others to do so.

Although the Fairhope Single Tax Corporation was founded on the principles enunciated in Henry George's book, *Progress and Poverty*, the colony is not now a true single tax colony, nor can it ever be. The Fairhope Single Tax Corporation is a private corporation with legal authority to rent its lands. The corporation cannot abolish all other taxes, nor can it levy a tax on land values. Thus the Fairhope Single Tax Colony is a simulation of the single tax principle in a society with a multitude of taxes. It has been properly called an enclave for single tax. The founders of the Fairhope Single Tax Colony were not financially able to acquire enough land in a single region to form a continuous area; therefore, corporation land is frequently surrounded by deeded property. The corporation owns approximately 20 percent of all the land inside Fairhope and less than one-half of one percent of the property in the county.

Single tax is simulated by a corporation by allowing, as a credit against rent payments, receipts for taxes paid by lessees to state, county, town, or school districts upon personal property and leasehold improvements. These credits for taxes are allowable up to the amount of rent. Thus, some tenants find that they owe no rent after allowances for personal property taxes. The corporation admitted in its annual statement that, "In 1965, the rent charged 26 percent of lessees was too little to pay their taxes and the corporation tax on land."

Those who advocate the single tax maintain that it is far superior to the present system in use in most of the United States. If there are many advantages of the single tax, the simulated single tax experiment should be able to demonstrate these advantages to outsiders and to the residents of Fairhope Single Tax Colony. The author has used both personal interviews and a mail questionnaire in an attempt to determine the advantages and disadvantages of the Fairhope Single Tax Colony. Naturally,

conventional methods of research, including an analysis of the statement issued by the corporation, were used to substantiate the findings from interviews and questionnaires.

An analysis of the annual statements of the Fairhope Single Tax Corporation during the period 1964-67 revealed that taxes paid by the corporation for lessees were approximately 46 to 55 percent of all rent collected. Public improvements, which consist mainly of expenditure on lands and highways and contributions to the Organic School, approximated 12 to 16 percent. Thus during the period 1964-67, the corporation returned almost two-thirds of all rent payments to lessees in the form of refunds of taxes paid and expenditure on public improvements.

Returning two-thirds of rent payments directly or indirectly to lessees is insignificant if land rents are high. In other words, the higher the land rents, the more the corporation could spend on public improvements. Land rents, however, are not high in Fairhope. According to the opinion of Dr. C. A. Gaston and economists who have studied land rents in Fairhope, the single tax colony has never collected the full economic rent on its lands (1). Moreover, it seems highly unlikely even after the increase in rents in 1967 that the capital values assigned to the land are high enough to reflect true market values for the land. In 1967, land rents were set so as to yield the corporation 6.645 percent on the unimproved value of the land. Since the corporation returns to lessees almost two-thirds of their rent in tax payments and public improvements, the net rent collected is about two percent of the relatively low capital values assigned to the land.

In view of the fact that the corporation has always spent part of its rent receipts to improve highways adjacent to corporation land, it would seem that the city should have more roads than cities of comparable size. An analysis of data provided by the state highway department, however, revealed that Fairhope does not have more highways than cities of comparable size. Likewise, a visual inspection of the roads in Fairhope did not impress the author.

Rent receipts not used to pay taxes for lessees and to buy public improvements are used to defray the cost of running the corporation and to some extent to accumulate a surplus. In recent years, the fear of higher real estate taxes has prompted the corporation to accumulate a rather large cash reserve. Lessees are, in effect, being forced to save toward a higher tax liability which may never be realized. This policy, while it seems justified by the circumstances, reduces the amount the corporation would otherwise spend for public improvements. During the period 1964-67, the forced saving amounted to only approximately 2 to 6 percent while the cost of administering the scheme averaged 12 to 15 percent, and taxes imposed upon the corporation amounted to 13 to 16 percent.

While it may be argued that the taxes imposed upon the corporation were just another means of paying taxes which are spent for the benefit of all, the administrative costs incurred by the corporation impose an added cost upon the people of Fairhope. The existence of the corporation

## Aspects of Single Tax Colony

means that a part of the resources of the community must be devoted to the administration of the single tax scheme. This is especially true since the corporation creates additional work rather than replacing attorneys and real estate agents.

The added cost of running the single tax colony as a percentage of rent receipts seems unusually high when measured by the experience of some cities in collecting property taxes. Dick Netzer has estimated that the average cost of collecting property taxes ranges from 1 to 1½ percent of the revenue collected (5). It thus appears that the Fairhope Single Tax Colony is too small to realize the economies which usually accompany a large scale operation. For economy of operation, the colony should be many times as large as it is. Some economists, however, believe that a high cost of administering a land tax is to be expected. According to David McCord Wright, countries which have tried land taxation have found that the cost of administering the tax is out of proportion to the revenue collected (3).

Despite the apparent high cost of administering the single tax scheme, it would seem that the people of Fairhope benefit from the scheme. In order to determine the opinions of the people of Fairhope regarding the single tax scheme, the author mailed approximately 340 questionnaires to residents of Fairhope in January, 1969. Of this number, 110 were completed and returned. One tabulation of the replies to the questionnaire is shown in Table 1.

The respondents were almost evenly divided between those who rent single tax property and those who own deeded property. Approximately 60 percent of the residents of Fairhope reside on corporation land while almost 50 percent of the replies were from this group. A city with single tax property interwoven with deeded property is an unfavorable place to test a social experiment such as the single tax. Henry George expressed the opinion in 1889 that, "the single tax cannot be fairly tried on a small scale in a community not subject to single tax (7)."

When questionnaires were tabulated in two groups--those who rent and those who own property--the differences in the opinions of these two groups were immediately apparent (Table 1, questions 2, 3 and 4). Persons living on single tax land believed in the principles upon which the Fairhope Single Tax Colony was founded, and they believed that the corporation has helped them and their city. Landowners, in general, did not believe that people who rent property benefit, nor did they believe that the city has benefited. Moreover, as might be expected, landowners did not believe in the principles upon which the Fairhope Single Tax Corporation was founded.

A healthy, but vocal minority of respondents not only believed that the Fairhope Single Tax Corporation had not benefited the city but they also expressed the opinion that the corporation had held back the progress of the city. The opinions reported and expressed by these few respondents seemed to be in direct opposition to the opinions of some of the friends of the single tax colony. Dr. C. A. Gaston, chief spokesman and secretary of the corporation, expressed the opinion that, "Fairhope has outdistanced all of them (cities near Fairhope) in growth."

TABLE 1. Responses to single tax questionnaire.

QUESTIONS	REPLIES (%)			Total
	Lessees	Landowners		
1. Do you rent property from Fairhope Single Tax Corporation?	Yes No	100.0 0.0	0.0 100.0	46.1 53.9
2. Do you believe in the principles upon which Fairhope Single Tax Corporation is founded?	Yes No	71.4 28.6	25.0 75.0	47.5 52.5
3. Do you believe that the city of Fairhope has benefited from Fairhope Single Tax Corporation?	Yes No	64.2 35.8	27.8 72.2	45.8 54.2
4. Do you believe that persons occupying Fairhope Single Tax Corporation land benefit?	Yes No	64.2 35.8	36.5 63.5	50.5 49.5
5. Do you believe that all taxes except taxes on land value should be abolished?	Yes No	31.3 68.7	20.0 80.0	25.8 74.2
6. Do you believe that the taxes collected from a tax on land value would be sufficient to support government?	Yes No	28.3 71.7	15.0 85.0	20.8 79.2
7. If you had a choice, would you prefer to rent or buy land?	Rent Buy	34.6 65.4	5.0 95.0	18.8 81.2
8. Do you believe that it is easier to rent or purchase property?	Rent Purchase	64.6 35.4	45.5 54.5	54.4 45.6
9. Are you familiar with the ideas expressed by Henry George?	Yes No	61.5 38.5	46.0 54.0	53.9 46.1

## Aspects of Single Tax Colony

Dr. Paul L. Alyea, also, has expressed a similar opinion. He said (1), "Just as the urban community of Fairhope has outdistanced its neighbors, that proportion of the area within the municipality belonging to the single tax corporation has been developed more intensively, and with greater uniformity, than has much of the remainder of the city."

Dr. Gaston is correct in asserting that Fairhope has grown faster than nearby cities. Table 2 indicates that the compound percentage change in Fairhope's population during the 1920-60 period has not only exceeded that of the nearby cities of Bay Minette and Daphne but also that of the state as a whole.

TABLE 2. Percentage change in population for Alabama and selected cities, 1920-1960.

Area	Compound percentage
Alabama	0.8
Baldwin County	2.2
Bay Minette	4.0
Daphne	3.1
Fairhope	4.4
Mobile	3.1

<sup>1</sup>Since this table is based upon percentage changes, the figures are strongly influenced by the different magnitude of the bases.

Source: (6).

Fairhope has also been able to surpass cities of similar size in other measures of economic development such as educational achievement and family income. For a city its size, Fairhope had the highest median school years completed (12.2 years) and also the highest percent of families (10 percent) with incomes of over \$10,000 in 1960. Although it seems improper to say the city has no poverty, Fairhope had one of the lowest percentages of families with incomes of under \$3,000 in 1960 (6). The income measures seem rather unusual for a city with one of the lowest percentages of persons employed in manufacturing.

Dr. Alyea's contention that Fairhope Single Tax Corporation land has been more intensely utilized is borne out by the fact that the 20 percent of the land inside Fairhope owned by the corporation contains approximately 50 percent of the assessed value of real estate in the city. Moreover, the less than one percent of the land owned by the corporation in the county contains approximately 5 percent of the assessed value. Single tax property is of declining importance because the corporation is not buying more land and most of its lands within Fairhope are already in use. It seems evident that the more intensive use of corporation land is no doubt due to the single tax doctrine.

If nearby cities were similar to Fairhope, it would be easy to



compare them with Fairhope. While Fairhope has only the advantage of the single tax colony, Daphne is more advantageously located and Bay Minette has a higher proportion of persons employed in manufacturing. Despite the apparent advantages enjoyed by both Daphne and Bay Minette, Fairhope has been able to surpass them in growth. Notwithstanding opinions expressed by respondents to the contrary, it seems inescapable that some of Fairhope's achievements must be due to the Fairhope Single Tax Colony. The apparent economic advantage of renting land may have attracted some persons to Fairhope who would have settled elsewhere.

Since the corporation pays state and local taxes (real estate and automobile taxes), for its lessees not to exceed the annual rent charged, it would seem evident that there is an economic advantage in renting land. However, only slightly over 60 percent of those living on colony land believe that they receive a benefit from living on corporation land. One respondent went so far as to outline in detail the nature of the economic benefit he receives. He said, "The 50' X 100' Single Tax city lot on which my \$8,000 home is constructed would readily bring \$2,000 on the real estate market. A yearly interest of 5% for this sum would amount to \$100--my current yearly "rent" amounts to \$70 per year--a savings of \$30 for not owning deeded property. The Single Tax Corporation also pays my property taxes for being a lessee, which would possibly amount to \$50 per year, thus, I am earning a total of \$80 a year by not having deeded property."

Although persons benefit economically from renting land, they may prefer to buy rather than rent. This is exactly what some respondents said. While only 50 percent of all respondents believe that persons renting single tax land benefit, slightly over 80 percent of all respondents prefer to buy (Table 1, questions 4 and 7). Many persons who believe that it is easier to acquire rental land still prefer to buy (questions 7 and 8). The advantage of the easy access to single tax property may only be slight since land can be easily purchased with borrowed funds.

Some persons who believe that they benefit from renting land may not be giving consideration to the fact that landowners frequently profit from rising land values. Of course, the avowed purpose of the corporation is to prevent land speculation. In general, the corporation has been successful in preventing speculation in its lands. One person interviewed probably expressed a view held by many regarding land speculation. He said at his age he preferred to rent land, but if he were younger he would prefer to buy land as an investment.

Early in the century, officials of the corporation privately bought land for the avowed purpose of demonstrating how sinful speculating in property can be. In addition to the universal tendency to speculate in land, land ownership frequently is viewed as a mark of social and political status rather than as a source of wealth or as a means of production.

The economic benefit of renting land may also be offset by the fact that some persons resent the control of land by the corporation. A 99 year lease gives one as much legal control over the leased land as land

## Aspects of Single Tax Colony

which is owned, with two exceptions: to mortgage property and to transfer lease contracts the lessee must get the approval of the corporation. In most cases the approval of the corporation is given in a routine manner. The corporation does reserve the right to refuse approval of transfer of lease contracts where people are attempting to make a profit from holding corporation land. This puts the corporation in the position of determining if a profit is being made from the transfer of the lease. It would not be difficult to understand that many would prefer to transfer their leaseholds without disclosing all of this information to the corporation. Moreover, since property taxes have been rather low and stable in Alabama, the more frequent increases in land rents by the corporation is no doubt resented by some. On the other hand, if property taxes were increased frequently or were higher, more people in Fairhope might prefer single tax land.

Responses to other questions on the questionnaire provided few surprises. As might be expected, a majority of respondents did not believe in the single tax doctrine or that such a tax would be sufficient to support all government (Table 1, questions 5 and 6). Despite the relative simplicity of the single tax doctrine, only slightly over half of the respondents believed they are familiar with the ideas expressed by Henry George (question 9). Surprisingly, persons who profess an understanding of the works of Henry George also prefer to buy rather than rent. This fact may indicate that Henry George's followers today are correct in supporting land value taxation rather than a drastic alteration of the institution of private ownership of property.

### CONCLUSION

The Fairhope Single Tax Corporation is attempting to simulate a single tax through renting its lands and allowing as credits against rent payments taxes paid on personal property and leasehold improvements.

The more intensive use of corporation land and the fact that Fairhope has surpassed other cities in growth seem to lead to the conclusion that the people of Fairhope do benefit from the single tax colony.

Despite the fact that many persons benefit economically from the single tax colony, this economic benefit is apparently offset by the desire to own property. Regardless of the multitude of benefits flowing from the single tax scheme, it is simply out of step with the personal desires of most of the residents of Fairhope who prefer to own land. If a social experiment is to be successful, it must take into account the personal preferences of individuals.

### ACKNOWLEDGMENT

The author is indebted to Dr. N. J. Cervera for helpful discussions and comments at various stages of the research.

LITERATURE CITED

1. Alyea, Paul E. and Blance R. Alyea. 1956. Fairhope 1894-1954. University of Alabama Press, Tuscaloosa.
2. Brown, Harry Gunnison. 1955. Land-value taxation around the world. The Robert Schalkenbach Foundation, New York.
3. Cord, Steven B. 1965. Henry George: dreamer or realist?. University of Pennsylvania Press, Philadelphia.
4. George, Henry. 1955. Progress and poverty. The Robert Schalkenbach Foundation, New York.
5. Netzer, Dick. 1966. Economics of property taxation. The Brookings Institution, Washington.
6. U.S. Department of Commerce, Bureau of Census, U.S. Census of Population, Vol. 1, part 2.
7. Young, Arthur Nichols. 1916. The single tax movement in the United States. Princeton University Press, Princeton.

## Epistemological Significance of Verstehen

### THE EPISTEMOLOGICAL SIGNIFICANCE OF VERSTEHEN WITHIN THE FRAMEWORK OF MANAGEMENT OF ORGANIZATION THEORY\*

W. Jack Duncan  
Samford University  
Birmingham, Alabama

Human society is not merely a fact or an event in the external world to be studied by an observer like a natural phenomenon... it is illuminated with meaning from within by the human beings who continuously create and bear it as the mode and condition of their self-realization.

--Eric Voegelin

Perhaps it is too obvious to mention that management and organization theorists have voiced "scientific" concern about their subject matter for decades. Attempts have been made to derive "principles" from everything ranging from the Bible to the Cameralistic science developed in Germany around the doctrine of administration by the territorial prince.

In spite of this concern, one is inclined to wonder if even today we fully recognize that the unrestricted search for universal invariants is not sufficient cause to classify an enterprise of this nature as scientific. Indeed, science requires that this quest be conducted according to some rather rigorous rules. The establishment of these guidelines is normally discussed within the confines of methodology.

Since methodology is the logic of methods, its function is to judge the numerous variations of the deductive and inductive processes as to their scientific validity. The objective of this type of inquiry is to standardize or at least isolate that portion of total variation in scientific findings which results from "methodological variance."

#### *Some Fundamental Considerations*

Students of specialized disciplines, physical or social, are usually reluctant to discuss the philosophy of their science. Perhaps the most important single factor contributing to this indifference is the unique vocabulary that must be mastered before much progress can be made. The study at hand is no exception to this dismal prospect.

#### *Elaborations on Unfamiliar Terms*

An effort will be made throughout the paper to define any unusual word at its point of usage. However, two words, both of which are contained in the title, are so basic to an understanding of the subject that they deserve special attention.

---

\*For those interested in the epistemology of management theory many of the ideas presented in this paper have been extended and some additional interpretations have been given in a paper by the author entitled, *The Concept of Ideal Types As a Method of Understanding Organizational Behavior*, *Management International Review*, No. 7 (January, 1971), pp. 19-28.

*Epistemology.* Epistemology is that part of philosophy which relates to the theory of knowledge. It is associated with questions regarding the kinds of knowledge and the processes by which it can be obtained.

Sciences are concerned with knowledge, and because of this association, epistemology becomes the most basic of the scientist's interests. The scientist *qua* epistemologist concentrates his attention upon the relationship between the theoretical and perceptual images one constructs and the objective reality to which these images refer.<sup>1</sup>

Generally speaking there are two dominant epistemological orientations evident among social scientists. The first, and perhaps the most common today, is known as empiricism. Scientific testability, to this group means direct confirmation of objective data obtained by sensory observation.<sup>2</sup> Concepts are based on sense impressions and theories result from the inductive process consisting of the generalization of propositions on the basis of the examination of specific cases.<sup>3</sup> One need only examine the works of Roethlisberger, Herzberg or Likert to find evidence of empiricism in management and organizations.

The other position, which I shall call a *priorism*, argues that the key to true knowledge is not by the evidence of sense but through pure thought and logic.<sup>4</sup> In essence, the *a priorists* maintain that if one begins with universal truths and follows the rules of logic the consequences he deducts must be as certain as the premises upon which they are based.<sup>5</sup> Perhaps the most familiar example of this orientation is Maslow's theory of human needs and some of Herbert Simon's work with rational models.<sup>6</sup>

Both of these "arguments" recommend methods for understanding human actions in organizations. However, the question of understanding brings us to the second term that requires special attention.

*Verstehen.* Verstehen relates to a type of knowledge initially described as *das spezifische Verstehen der Geisteswissenschaften*. Translated literally, Verstehen means understanding. However, this is a special type of understanding possible only in the social sciences where both the observer and the observee are members of the same general class of organisms.

McIver, in his *Social Causation*, makes the following observation:

(In the social realm) we must supplement the experiment and the "objective evidence" provided by observable and measurable behavior with the admittedly precarious but valuable process of imaginatively reconstructing the hidden systems of thoughts, attitudes and desires to which casual efficacy is imputed.<sup>7</sup>

Verstehen, in effect, is the postulation of an intervening process located within the human organism by means of which the observed behavior of others is made meaningful.<sup>8</sup> Accordingly, the reaction or response to any stimuli supposes the existence of mental determinants such as memory, desires and expectations.<sup>9</sup>

## Epistemological Significance of Verstehen

It seems reasonable to say that the objective of science is understanding. However, this is not the specific type of understanding to which Verstehen refers. Scientific understanding is directed toward actions or the significance which attaches to an action in light of some appropriate theory. Verstehen, on the other hand, deals with act meanings or the significance which attaches to an act in light of the goals and purposes of the one performing it.<sup>10</sup> It simply interprets physical phenomena in terms of their psychological and sociological meanings. But, in order to fully comprehend Verstehen, additional considerations are necessary.

### *Cognition from Within*

Natural phenomena are approached from without. The result of such observations is the establishment of laws of dependence by which one explains nature.<sup>11</sup> In the natural realm there are no act meanings--no purposes, no goals, and no expectations on the part of the innate "actors." Cognition is external and is obtainable through observation because there are no motivational functions to explain.

In the social realm cognition is more complex. To be sure there are externalities and action meanings but there are also internal factors. Human action can be externally observed but it must be explained from within. It is necessary, in other words, for the observer to understand the meaning of an act to the actor.

Internal cognition requires that the observer generalize his experience and apply it to the actions of others. If an observer found that stimulus  $p$  evoked response  $q$  from subject  $x$ , he would ask himself; if condition  $p$  existed and I embarked upon act  $q$ , what internal forces would have motivated me to do so.

Perhaps an example is in order. The writer knows of an incident in which a company issued a new ruling prohibiting overtime. The following day several key production workers resigned.

Behavioristic analysis can only report or describe the sequence of events. A stimulus (new ruling) was applied and a response (workers resigned) was evoked. This is obviously insufficient for purposes of explanation.

However, because the social scientist is human he can break the behavioristic chain and comprehend the motives of others. He can reconstruct, on the basis of his own understanding of human nature, the entire situation positioning himself in the observee's place. There are, to be sure, certain "facts" available to him.<sup>12</sup>

1. Reduced overtime (A) means lower pay (B).
2. Given a particular skill level, increased pay (C) can be obtained only through overtime (D).
3. A person needing money (B') will seek higher pay (C').



The first two elements (A-B) and their known consequences (C-D) are facts, but they require a psychological link. By reformulating B and C into "feeling-states of human organism" we obtain B' and C' which enables us to apply a generalization concerning the function of the organism (behavior maxim)<sup>13</sup> from which we can deduct that the new ruling is a cause of the worker's response. At this point we have generalized the situation in terms of our own experience. However, before proceeding, let us stop and consider the nature of the process by which we are able to understand the actions of others.

### *The Process*

Verstehen is accomplished in three distinct steps.<sup>14</sup> All are essential if the process is to be complete. They are executed in the following sequence.

*Internalizing the Stimulus.* The observer attempts to describe a situation or event by categorizing it and evoking personal knowledge which fits into the category. In the example above one simply views the new ruling and assumes himself in the production worker's position. Although the observing social scientist may have never been a production worker he can still "understand" the employee's feeling. Certainly he realizes the new ruling means lower income. What would any man feel if suddenly confronted with the same prospect? No individual is completely ignorant of the emotional state of other men in such a situation.

*Internalizing the Response.* Once again the observer is required to use his imagination in speculating about the motives of the "actor." In effect this involves an inference concerning the motives of an act from the known or observed modifications it produces. We might suspect, for instance, that the employee needs the money for hospital bills, house payments or college tuition for his children. It is certainly not difficult for modern man to understand the motives of others who are seeking higher pay. Motives relating to the accomplishment of other objectives may be considerably more difficult to ascertain.

*Application of Behavior Maxim.* Certain maxims link feeling states together in a uniform sequence and imply a functional dependence between them. They formulate, in other words, a form of psychic congruence. These maxims may even be *ad hoc* and quite acceptable, not because they are experimentally verifiable but because they are "intersubjectively self-evident."

Therefore, it can be seen that Verstehen depends upon generalized personal experience. But the primary question is still in doubt. Is it really important and is there any evidence of its existence in the literature of management and organization theory?

### *Some Incidents*

While introducing a particular study, Herbert Simon made the following observation.

## Epistemological Significance of Verstehen

Lacking the kinds of empirical knowledge of the decisional process that will be required for a definitive theory, the hard facts of the world, can enter the theory only in a relatively unsystematic way . . . but none of us are completely innocent of acquaintance with the gross characteristics of human choice . . . I shall feel free to call upon this common experience as a source of hypothesis.<sup>15</sup>

No doubt this "common experience" hints at a type of behavior maxim which enables man to understand subjective preferences when dealing with matters of choice. In effect, this proposition maintains that even though familiarity with ones self and others will not identify the choices which will be made, it will shed light on the process by which decisions are formulated.

Another author makes a similar statement about the decisional process of man.

The human actor is a multidimensional phenomenon subject to the influences of a great many variables . . . Our basic formulation is that human action emerges from the interaction of (1) the individual and (2) the situation . . . Thus, we assume that the purposive individual will try to exploit his opportunities in the direction of his aspirations.<sup>16</sup>

Once again the literature bears witness to a social scientist's generalization of personal experience and the imputation of motives into others on the basis of it. Little, if any, empirical data can be offered in support of the proposition, yet few would question its validity.

Many other examples could be noted to confirm the implicit and frequent use of Verstehen in management and organizations. Although additional elaborations might prove interesting, time forbids. Moreover, it is not the frequency of these incidents that is important but the epistemological significance of such observations. The determination of this factor is the objective of the following section.

### *An Evaluation*

Behavioral scientists have been less than unanimous in their support of Verstehen as an epistemological alternative. Criticisms have been directed toward it on a variety of grounds. Generally speaking, however, the objections can be grouped into two major categories; individual limitations in its use and methodological complications.

*Individual Limitations.* It has been established above that Verstehen requires the generalization of personal experience. Therefore, one's ability to explain human behavior is dependent on the quantity of his experience and his ability to generalize it.<sup>17</sup> Moreover, if the observer explains the motives of others on the basis of his experience nothing has really been added to society's "store of knowledge." Without any increase in knowledge serious questions concerning epistemological value can be raised.

Opponents also point out that the social disciplines are more subject to value-centric problems because of the personal preferences of social scientists. Since the scientist *qua* human being entertains social preferences his subject matter can provide his values with an unavoidable relevance.<sup>18</sup> The accuracy of predictions may be influenced, in other words, by the degree to which the values of the observer and observee "fuse." This possibility introduces a normative element which cannot be dealt with *via* scientific procedures. Complications of this nature cause the "skeptics" to discount any worth that might be assigned to *Verstehen*.

As destructive as these criticisms are, additional ones are also present. These, rather than relating to the frailties of the individual, concentrate upon the nature of the philosophy of management science itself.

*Methodological Problems.* Abel maintains that to "understand" a cause implies nothing more than recognizing a possible connection between an actor's motives and his action. He continues his argument by saying that we cannot even conclude anything about the likelihoods of the possible causal factors. In other words, when an observer imputes his motives into the actor's actions he develops only one possible connection which is no more or no less probable than an infinite number of other possible links. Also, there is an ever present element of uncertainty because it would be impossible to completely comprehend all the possible connections.

The final, and in my mind, the most serious criticism in either category, is that a superficially plausible connection might satisfy scientific curiosity and hinder the pursuit of additional possibilities. Perhaps at no other point does the *post hoc, ergo propter hoc* fallacy become so evident.

What about these criticisms? Do they constitute a force strong enough to destroy the usefulness of *Verstehen*?

#### *A Qualified Defense*

None of the before mentioned limitations constitute an insurmountable barrier to scientific acceptance of *Verstehen*. Although a person's experience in some areas may be limited his "practice at being a person" is daily exercise. In this area there is little doubt that time increases proficiency but one's process of maturation provides a rudimentary foundation of "understanding" human behavior. As the poet has written, "I am human and therefore nothing human is foreign to me."

The matter of likelihoods is also a matter of conjecture. It is entirely possible that techniques relating to subjective probabilities could isolate some of the extremely probable and extremely unlikely connections between stimulus and response.

As far as normative considerations are concerned, this is no less a problem of social sciences in general than it is of *Verstehen*. Values

simply cannot be completely separated from fact in the social disciplines. The existence of such a condition requires a type of academic honesty on the part of the researcher to make his values explicit and known. This does not remove the value-centric problem but it does bring it into the open and minimizes any distorting effect it might have.

The other criticisms cannot be disposed of so easily. I find myself in complete agreement with the proposition that Verstehen does not constitute its own verification. And, in the purest sense, it does not add anything to existing knowledge. However, it does provide valuable hypothetical links between two "feeling states" that may eventually guide the scientist to new scientific understanding. This is the key point that, if understood, can enable the researcher to use Verstehen with no fear of adverse consequences. Verstehen is a valuable source of hypotheses. In fact, it is the primary source of such information to the behavioral scientist. This data, if viewed as a hypothesis to be examined rather than an explanation to be accepted and filed away never to be evaluated again would encourage rather than retard scientific thinking. Verstehen is not an epistemological alternative but an integral part of both *a priori* and empiricism. Its use in the formulation of testable hypotheses gives it an epistemological significance which should not be discounted as meaningless rubbish. The insight provided by this process can remove some of the shell of uncertainty surrounding the nature of human action.

#### FOOTNOTES

<sup>1</sup>William P. McEwen. *The Problem of Social-Scientific Knowledge*, The Bedminster Press, Totowa, New Jersey, 1963, p. 6.

<sup>2</sup>Fritz Machlup. *The Problem of Verification in Economics*. The Southern Journal of Economics, Vol. XXII, No. 1 (July, 1955), p. 8.

<sup>3</sup>Herbert G. Hicks and Friedhelm Goronzy. *On Methodology in the Study of Management and Organizations*. Academy of Management Journal, Vol. X, No. 4 (Dec., 1967), p. 373. See also Mario Bunge. *The Place of Induction in Science*. Philosophy of Science, Vol. XXVII, No. 3 (June, 1960), p. 262.

<sup>4</sup>Felix Kaufmann. *Methodology of the Social Sciences*. The Humanities Press, New York, 1958, p. 10.

<sup>5</sup>Rollo Handy. *Methodology of the Behavioral Sciences*. Charles C. Thomas. Publisher, Springfield, Ill., 1964, p. 25.

<sup>6</sup>See Herbert Simon. *Compensation of Executives*. Sociometry, Vol. XX, No. 1 (March, 1957), pp. 32-35 and *A Formal Theory of Interaction in Social Groups*. American Sociological Review, Vol. XVII, No. 2 (April, 1952), pp. 202-211.

<sup>7</sup>Ernest Nagel. *Logic Without Metaphysics*. The Free Press, Glencoe, Illinois, 1956, p. 372.

<sup>8</sup>Theodore Abel. The Operation Called Verstehen. *American Journal of Sociology*. Vol. LIV, No. 3 (Nov., 1948), p. 213.

<sup>9</sup>Arthur Pap. *An Introduction to the Philosophy of Science*. The Free Press, Glencoe, Ill., 1962, p. 383.

<sup>10</sup>Abraham Kaplan. *The Conduct of Inquiry*. Chandler Publishing Company, San Francisco, 1964, p. 142.

<sup>11</sup>Ludwig Von Mises. *Epistemological Problems of Economics*. D. Van Nostrand Company, Inc., Princeton, 1960, p. 130.

<sup>12</sup>The schematic form I have chosen has been previously used by Abel, *op. cit.*, pp. 213.

<sup>13</sup>*Ibid.*

<sup>14</sup>*Ibid.*, pp. 215-216.

<sup>15</sup>Herbert A. Simon. A Behavioral Model of Rational Choice. *Quarterly Journal of Economics*. Vol. LXIX, No. 1 (Feb., 1955), p. 100.

<sup>16</sup>James D. Thompson. *Organizations in Action*. McGraw Hill Book Company, New York, 1967, pp. 101-102.

<sup>17</sup>Abel, *op. cit.*, p. 216.

<sup>18</sup>Kaplan, *op. cit.*, p. 138.

COMPARISON OF SOLUBLE PROTEINS BY GEL  
ELECTROPHORESIS OF SELECTED *CHLAMYDOMONAS* SPECIES

Robert G. Tucker and James D. Yarbrough<sup>1</sup>  
Department of Biology  
University of Alabama, University, Alabama

INTRODUCTION

Polyacrylamide gel electrophoresis is a technique of wide biological application. Combining simplicity and speed of operation with greatly increased sensitivity of sample separations, it has been applied to a number of taxonomic problems in both plant and animal groups. Included in this work has been Chang, *et al.* (1) analysis of soluble proteins of *Neurospora*; Sindermann and Honey (7) determining banding patterns of the hemoglobins of five species of Clupeoid fish; Kates and Goldstein (4) comparing soluble proteins of several species of *Amoeba*; and Johnson, *et al.* (3) analyzing genome and species relationships in polyploid wheats by soluble protein banding patterns.

To apply polyacrylamide gel electrophoresis to algal taxonomy, three closely related species of *Chlamydomonas* were selected: *Chlamydomonas reinhardtii* Dangeard separated from *Chlamydomonas radiata* Deason and *Chlamydomonas actinochloris* Deason on the basis of plastid shape, and *Chlamydomonas radiata* distinguished from *C. reinhardtii* and *C. actinochloris* on the basis of nuclear placement.

MATERIALS AND METHODS

Forty-four different soluble protein samples of *Chlamydomonas* were used for electrophoretic analysis. These included 10 samples each of (+) and (-) mating-type *C. reinhardtii*, eight samples of *C. actinochloris* and eight samples each of an Alabama and Texas strain of *C. radiata*. *C. reinhardtii* strains were obtained from the Indiana University algal culture collection (8); *C. actinochloris* and *C. radiata* were obtained from T. R. Deason, University of Alabama.

All cultures were grown axenically on agar plates using a modification of Bristol's inorganic salt medium (2) in which the concentration of  $\text{NaNO}_3$  was tripled. Samples were grown for three week periods, harvested, and decolorized with 95% ethanol. The alcohol treatment was necessary because of chlorophyll interference with later analysis. However, samples that were not decolorized were compared to decolorized samples and no apparent differences in banding patterns were observed. Cells were broken by grinding in a mortar with repeated use of liquid air during a 30-45 minute period. Tris-glycine buffer, pH 8.3, was added periodically during the grinding to bring the final volume to approximately 3 ml. Cellular fragments were removed by centrifugation at  $15,000 \times g$  at 0 C for 15 minutes. Protein concentration of each sample was determined by the colorimetric procedure of Lowry (5). All samples were adjusted to a final protein concentration of 1200  $\mu\text{g/ml}$ .

<sup>1</sup>Present address: Department of Zoology, Mississippi State University, State College, Mississippi.



Acrylamide gels were prepared from stock chemicals supplied by the Canasco Company, and consisted of the standard 7% polyacrylamide separating, standard stacking, and sample gel mixtures. All gels were chemically polymerized in glass tubes 60 mm long by 5 mm in diameter. Electrophoresis was for a 1 hr period with 5 ma of current per sample tube at room temperature. Samples were stained with aniline blue black for 1 hr and destained using 12.5 ma of current per tube for 1 hr and stored in 7% acetic acid.

Densitometric tracings were obtained with a Spinco Analytrol Model RB and a model R-102 microzone scanning attachment. Percent protein per component peak was calculated for each resolvable band. Relative mobility ( $R_m$ ) values were also calculated; these values represent a ratio of the total migration distance of each component from the interphase of the stacking-separating gel to the total migration distance of each component through the separating gel. Standard deviation and standard error were computed for each percent protein per component and for each  $R_m$  value selected for comparison. The student t-test was applied to the  $R_m$  values of compared components. Selection of components to be compared was based on overlapping  $R_m$  values among different samples and closeness of the mean  $R_m$  values.

## RESULTS

All *Chlamydomonas* species analyzed showed differences in electrophoretic banding patterns. The only bands used for analysis were those which could be distinguished visually and resolved by the densitometer.

Results in terms of mean percent protein, standard deviation, and standard error for each component of each species and strain are shown in Tables 1 and 2. All samples represented a different electrophoretic run and culture sample. A high degree of reproducibility was apparent among different samples of the same species or strain. Component peaks resolved with the densitometer were numbered in relation to their mobility, with the highest numbered component representing the most mobile protein complex. The narrow range obtained for percent protein for any component within a series of the same type sample is evidenced by their low standard deviations and standard errors. These values were not used to compare components from one species to another, but they emphasize the reproducibility among different samples of the same species or strain. The (+) mating-type of *C. reinhardtii* contained 12 components with the 7, 9 and 10 components containing the largest percent protein. The (-) mating-type of *C. reinhardtii* contained 10 components. Component 7 of the (-) strain was visually separated from component 6, but no separation of these components was obtained with the densitometer and it is referred to as the 6-7 complex. Components 9 and 12 in the (+) and 7 and 12 in the (-) strains of *C. reinhardtii* were each composed of two separate bands, but were not separated by the densitometer. In the (-) mating-type, components 1, 4, 5 and 6-7 complex contained the highest percent protein.

There was a high degree of reproducibility of  $R_m$  values per component among different samples of the same species and/or strain being

Soluble Proteins of *Chlamydomonas*

TABLE 1. Range of percent protein, mean percent protein, and standard deviation and error for each component protein band.

<i>Chlamydomonas reinhardtii</i> (+) strain					
Component Number	Number of Samples	Range % Protein	Mean % Protein	Stand. Dev.	Stand. Error
I	10	6.7 - 8.3	7.14	0.31	0.10
II	10	5.7 - 7.0	6.39	0.30	0.09
III	10	5.6 - 7.0	6.30	0.38	0.12
IV	10	5.8 - 6.8	6.27	0.32	0.10
V	10	8.5 - 10.6	9.67	0.63	0.20
VI	10	6.5 - 7.6	7.14	0.29	0.09
VII	10	11.1 - 12.6	11.80	0.40	0.13
VIII	10	7.0 - 8.5	7.78	0.47	0.15
IX	10	12.1 - 12.9	12.57	0.20	0.06
X	10	9.4 - 11.1	10.24	0.55	0.17
XI	10	5.8 - 6.7	6.20	0.40	0.13
XII	10	8.2 - 9.1	8.69	0.30	0.09
<i>Chlamydomonas reinhardtii</i> (-) strain					
I	10	7.6 - 10.0	8.59	0.68	0.22
II	10	7.4 - 9.2	8.27	0.41	0.13
III	10	10.0 - 12.7	10.90	0.64	0.20
IV	10	16.9 - 18.4	17.80	0.31	0.10
V	10	10.4 - 11.8	11.12	0.38	0.12
VI - VII	10	18.6 - 19.5	19.06	0.26	0.08
VIII	10	9.4 - 10.5	9.70	0.36	0.11
IX	10	3.6 - 5.00	4.06	0.31	0.10
X	10	9.4 - 11.4	10.57	0.45	0.14

analyzed. This is evidenced by the extremely low standard deviations and standard errors obtained for each component (Tables 3 and 4). Rm values of different species and strains were analyzed by the student t-test and based on the standard t-value at the 5 percent level were indicated as electrophoretically homologous or electrophoretically non-homologous (Table 5). Homology as used here refers to the patterned migration of a given protein complex and does not refer to the possible structural or functional unit that this complex may represent. Component 7 of the (+) strain and component 6 of the (-) strain of *C. reinhardtii* were homologous, as was the third component of *C. actinochloris* and *C. radiata* (Texas), and each were homologous to one another. Component 4 of both *C. radiata* (Texas) and *C. actinochloris* were homologous, as was component 10 of both strains of *C. reinhardtii* and each were homologous to one another. Component 5 of both strains of *C. reinhardtii* was a homologous component shared by these two mating types. No other homologies existed between compared components. The Alabama strain of *C. radiata* had no components which were found to be homologous with components of other strains or species.

TABLE 2. Range of percent protein, mean percent protein, and standard deviation and error for each component protein band.

<i>Chlamydomonas radiata</i> (Alabama)					
Component Number	Number of Samples	Range % Protein	Mean % Protein	Stand. Dev.	Stand. Error
I	8	28.5 - 35.5	32.63	1.94	0.69
II	8	31.7 - 35.8	33.75	1.33	0.47
III	8	17.7 - 21.6	20.23	0.69	0.24
IV	8	7.3 - 9.1	8.40	0.86	0.30
V	8	3.8 - 6.2	5.16	0.84	0.30
<i>Chlamydomonas radiata</i> (Texas)					
I	8	9.1 - 12.0	10.79	0.93	0.33
II	8	22.2 - 25.3	23.55	0.89	0.31
III	8	41.5 - 44.7	43.10	1.06	0.37
IV	8	13.6 - 17.3	15.35	1.34	0.47
V	8	5.3 - 7.1	6.10	0.47	0.17
VI	8	1.0 - 1.9	1.25	0.37	0.13
<i>Chlamydomonas actinochloris</i>					
I	8	14.3 - 19.0	17.04	1.07	0.38
II	8	15.6 - 21.1	17.74	1.46	0.52
III	8	21.0 - 21.1	23.21	1.38	0.49
IV	8	21.1 - 25.0	27.30	0.89	0.31
V	8	9.8 - 12.3	11.36	0.90	0.32
VI	8	3.5 - 5.4	4.48	0.80	0.28

Based on the  $R_m$  values, a total of 30 components was established (Table 6). The least mobile component of all species was component 1, and the most mobile component was number 30. Of these 30, components 15 and 20 were calculated to be homologous between all species and strains with one exception, the Alabama strain of *C. radiata*. Component 10 was homologous between the (+) and (-) mating-types of *C. reinhardtii*.

#### DISCUSSION

The techniques for analysis of the bands obtained by electrophoresis are varied. They include visual analysis, comparison of densities of individual bands, mixture comparisons of the proteins and mobility calculations. Of these, visual analysis is the least accurate. It relies on comparing major bands, assuming they are homologous, and looking for deletions or additions. Density comparisons are more valid, provided destaining is uniform and migration distance does not vary. This method assumes that the densest staining bands are homologous. Mixture analysis seems to offer a better procedure for

Soluble Proteins of *Chlamydomonas*

TABLE 3. Range of Rm values, mean Rm values, and standard deviation and error for each component protein band.

<i>Chlamydomonas reinhardtii</i> (+) strain					
Component Number	Number of Samples	Range of Rm Values	Mean of Rm Values	Stand. Dev.	Stand. Error
I	10	0.085 - 0.126	0.099	0.006	0.002
II	10	0.203 - 0.219	0.214	0.004	0.001
III	10	0.243 - 0.254	0.252	0.003	0.001
IV	10	0.288 - 0.305	0.299	0.004	0.001
V	10	0.333 - 0.348	0.343	0.003	0.001
VI	10	0.390 - 0.404	0.400	0.004	0.001
VII	10	0.461 - 0.471	0.467	0.004	0.001
VIII	10	0.522 - 0.534	0.527	0.003	0.001
IX	10	0.550 - 0.565	0.560	0.004	0.001
X	10	0.621 - 0.627	0.623	0.002	0.001
XI	10	0.691 - 0.706	0.696	0.003	0.001
XII	10	0.797 - 0.823	0.802	0.005	0.002
<i>Chlamydomonas reinhardtii</i> (-) strain					
I	7	0.076 - 0.081	0.079	0.002	0.001
II	7	0.244 - 0.251	0.247	0.002	0.001
III	7	0.338 - 0.346	0.342	0.003	0.001
IV	7	0.391 - 0.398	0.395	0.003	0.001
V	7	0.464 - 0.474	0.468	0.004	0.002
VI - VII	7	0.547 - 0.550	0.549	0.002	0.001
VIII	7	0.616 - 0.626	0.621	0.003	0.001
IX	7	0.668 - 0.672	0.672	0.001	0.0003
X	7	0.791 - 0.797	0.792	0.792	0.001

TABLE 4. Range of Rm values, mean Rm values, and standard deviation and error for each component protein band.

<i>Chlamydomonas radiata</i> (Alabama)					
Component Number	Number of Samples	Range of Rm Values	Mean of Rm Values	Stand. Dev.	Stand. Error
I	8	0.417 - 0.428	0.423	0.003	0.001
II	8	0.544 - 0.560	0.554	0.003	0.001
III	8	0.622 - 0.655	0.645	0.008	0.003
IV	8	0.756 - 0.769	0.764	0.004	0.001
V	8	0.783 - 0.841	0.824	0.023	0.008

TABLE 4. Continued

<i>Chlamydomonas radiata</i> (Texas)					
I	5	0.275 - 0.279	0.276	0.001	0.0004
II	5	0.326 - 0.335	0.330	0.004	0.002
III	5	0.465 - 0.474	0.470	0.003	0.001
IV	5	0.619 - 0.629	0.625	0.004	0.004
V	5	0.712 - 0.720	0.717	0.004	0.002
VI	5	0.767 - 0.770	0.768	0.001	0.0004
<i>Chlamydomonas actinochloris</i>					
I	8	0.306 - 0.314	0.309	0.002	0.001
II	8	0.398 - 0.410	0.404	0.003	0.001
III	8	0.457 - 0.493	0.466	0.008	0.003
IV	8	0.617 - 0.647	0.625	0.006	0.002
V	8	0.722 - 0.731	0.728	0.003	0.001
VI	8	0.776 - 0.782	0.779	0.003	0.001

homology determination. However, as reported (3), this analysis is based on "selected" markers that may or may not be homologous. Rm values offer a more satisfactory analysis method. Richards, *et al.* (6) carried out gel analysis using Rf (Rm) values of separated RNA and reported highly reproducible results if migration time, current, and gel concentrations were held constant.

In this study, visual comparisons of the banding patterns indicated a close relationship between *C. reinhardtii* (+) and (-) strains and a close relationship between *C. radiata* (Texas) and *C. actinochloris*. By visually comparing (+) and (-) mating types of *C. reinhardtii* it appeared that component bands 2 and 4 were missing in the (-) mating type and that an 8-9 complex existed that was not present in the (+) mating type. All other bands appeared homologous. However, when comparisons were made with reference to protein mobility, there was a surprising lack of homology with only three homologues out of the total of 22 protein components. Further, it appeared that there was as close a relationship between *C. reinhardtii*, *C. radiata* (Texas) and *C. actinochloris*, as there was between the mating types of *C. reinhardtii*. The mating types shared only one more homologous band than the other two species (Table 6). The number of component bands in *C. radiata* (Texas) and *C. actinochloris* were reduced to 12. Of these, two bands were homologous, components 3 and 4. There was a slightly higher percentage of homology between these than between the (+) and (-) mating types of *C. reinhardtii*. There was also a closer relationship between *C. actinochloris* and *C. radiata* (Texas) than between *C. radiata* (Texas) and *C. radiata* (Alabama). Although no homologous bands exist between these two strains, statistical analyses indicated that several bands were exceedingly close to the values that would produce homology.

TABLE 5. Homologous and non-homologous comparison of component bands on t-value.

Component Compared		t-scores	Standard t at 5% Level	Homology
1) <i>C. reinhardtii</i> (+) # IX -- <i>C. radiata</i> (Ala.) # II		4.28	2.12	Non-homologous
2) <i>C. reinhardtii</i> (+) # VI -- <i>C. actinochloris</i> # II		2.85	2.12	Non-homologous
3) <i>C. reinhardtii</i> (+) # VII -- <i>C. actinochloris</i> # III		0.316	2.12	Homologous
4) <i>C. reinhardtii</i> (+) # V -- <i>C. actinochloris</i> # IV		0.909	2.12	Homologous
5) <i>C. reinhardtii</i> (+) # VII -- <i>C. radiata</i> (Texas) # III		2.14	2.16	Homologous
6) <i>C. reinhardtii</i> (+) # X -- <i>C. radiata</i> (Texas) # IV		0.909	2.16	Homologous
7) <i>C. reinhardtii</i> (+) # III -- <i>C. reinhardtii</i> (-) # II		3.57	3.13	Non-homologous
8) <i>C. reinhardtii</i> (+) # V -- <i>C. reinhardtii</i> (-) # III		0.714	2.13	Homologous
9) <i>C. reinhardtii</i> (+) # VI -- <i>C. reinhardtii</i> (-) # IV		3.57	2.13	Non-homologous
10) <i>C. reinhardtii</i> (+) # VII -- <i>C. reinhardtii</i> (-) # IV		0.454	2.13	Homologous
11) <i>C. reinhardtii</i> (+) # X -- <i>C. reinhardtii</i> (-) # VIII		1.43	2.13	Homologous
12) <i>C. reinhardtii</i> (-) # IV -- <i>C. radiata</i> (Tex.) # III		0.909	2.23	Homologous
13) <i>C. reinhardtii</i> (-) # VIII -- <i>C. actinochloris</i> # IV		1.81	2.16	Homologous
14) <i>C. reinhardtii</i> (-) # VIII -- <i>C. radiata</i> (Tex.) # IV		1.81	2.23	Homologous
15) <i>C. reinhardtii</i> (-) # VIII -- <i>C. radiata</i> (Ala.) # II		3.57	2.16	Non-homologous
16) <i>C. reinhardtii</i> (-) # IV -- <i>C. actinochloris</i> # III		0.555	2.16	Homologous
17) <i>C. radiata</i> (Ala.) # IV -- <i>C. radiata</i> (Tex.) # VI		3.33	2.20	Non-homologous
18) <i>C. radiata</i> (Tex.) # IV -- <i>C. actinochloris</i> # IV		0.000	2.20	Homologous
19) <i>C. radiata</i> (Tex.) # III -- <i>C. actinochloris</i> # III		1.26	2.20	Homologous



TABLE 6. Summary of components of soluble proteins based on Rm value. Plus indicates presence of components by species or strain; minus indicates absence.

Components	Rm Value	<i>C. reinhardtii</i> (+) strain	<i>C. reinhardtii</i> (-) strain	<i>C. radiata</i> Ala. strain	<i>C. radiata</i> Texas strain	<i>C. actino- chloris</i>
1	0.079	-	+	-	-	-
2	0.099	+	-	-	-	-
3	0.214	+	-	-	-	-
4	0.247	-	-	-	-	-
5	0.252	+	-	-	-	-
6	0.276	-	-	-	+	-
7	0.299	+	-	-	-	-
8	0.309	-	-	-	-	-
9	0.330	-	-	-	+	-
10	0.342 - 0.343	+	+	-	-	-
11	0.395	-	+	-	-	-
12	0.400	+	-	-	-	-
13	0.404	-	-	-	-	+
14	0.425	-	-	+	-	-
15	0.466 - 0.470	+	+	-	+	+
16	0.527	+	-	-	-	-
17	0.549	-	+	-	-	-
18	0.554	-	-	+	-	-
19	0.560	+	-	-	-	-
20	0.621 - 0.625	+	+	-	+	+
21	0.645	-	-	+	-	-
22	0.696	+	-	-	-	-
23	0.717	-	-	-	+	-
24	0.728	-	-	-	+	-
25	0.764	-	-	+	-	-
26	0.768	-	-	-	+	-
27	0.779	-	-	-	-	+
28	0.792	-	+	-	-	-
29	0.802	+	-	-	-	-
30	0.824	-	-	+	-	-

## Soluble Proteins of *Chlamydomonas*

Of the 30 components identified by Rm values three components showed electrophoretic homology. This low percentage of homology was somewhat puzzling due to the morphological closeness of the species studied. What may constitute for a given species, strain, or a genus the base number of homologous protein complexes is highly problematical. However, we would expect this base number to be greater in mating types than between species and greater between strains than species. This is not the case, and would indicate that either the base number is too low to be statistically valid or that *C. radiata* (Alabama) needs to be separated from the Texas strain and the Texas strain placed with *C. actinochloris*. It would seem the former conclusion is correct and that soluble protein analysis by gel electrophoresis cannot be used as a tool for systematic grouping in the algae.

### LITERATURE CITED

1. Chang, L. O., A. M. Srb, and F. C. Steward. 1962. Electrophoretic separations of the soluble proteins of *Neurospora*. *Nature* 193: 756-759.
2. Deason, T. R., and H. C. Bold. 1960. Exploratory studies of Texas soil algae. University of Texas Publ. # 6022, Phycological Studies # 1.
3. Johnson, B. L., D. Barnhurt, and O. Hall. 1967. Analysis of genome and species relationships in the polyploid wheats by protein electrophoresis. *Am. J. Bot.* 54:1089.
4. Kates, J. R., and L. Goldstein. 1964. A comparison of the protein composition of three species of *Amoeba*. *J. of Protozool.* 11:30-35.
5. Lowry, O. H., N. J. Rosebrough, A. L. Farr, and R. J. Randall. 1951. Protein measurements with the folin phenol reagent. *J. Biol. Chem.* 193:265-273.
6. Richards, E. G., J. A. Coll, and W. B. Gratzner. 1965. Disc electrophoresis of ribonucleic acid in polyacrylamide gels. *Anal. Biochem.* 12:452-471.
7. Sindermann, C. J., and K. A. Honey. 1963. Electrophoretic analysis of the hemoglobins of Atlantic *Clupeoid* fishes. *Copeia* 3:534-537.
8. Starr, R. C. 1964. The culture collection of algae at Indiana University. *Am. J. Bot.* 51:1013-1044.

SPECTROSCOPIC MEASUREMENTS OF VELOCITIES IN JETS

T. G. Roberts and W. L. Hales  
U.S. Army Missile Command  
Redstone Arsenal, Alabama

INTRODUCTION

Measuring the Doppler shift of the emitted spectral lines has been found an effective means of determining the velocities of gases in supersonic plasma jets (1,4,5,6,7). It provides a direct comparison of the flow velocity with the velocity of light, and is much simpler than other methods. This technique does not require disturbing the flow in any manner, seeding the plasma, or assuming any special properties for the plasma, e.g., local thermodynamic equilibrium or satisfying a local Ohm's law. The only condition is that the jet should be reasonably steady during the time required to obtain the spectra since the measured velocities are averaged over this period. Bundy and Strong (2) used this technique to determine the gas velocity at the exit of the nozzle of a rocket motor, employing a filter, a Fabry-Perot interferometer, and a camera to photograph the interference fringes of the sodium D-lines. This radiation was obtained by seeding the rocket motor with sodium, which was assumed to have the same velocity as the other gases.

The method reported here differs from Bundy's in that a fast spectrograph is used instead of the filter and camera. The spectrograph makes it possible to determine the velocity by measuring the shift of many lines for each run, and thus to set limits on the accuracy of the results. It is not necessary to make any assumptions about the velocities of the different gases, since they can be determined for each species which emits lines in the spectral region covered. For example, if an electric field is applied in the flow direction, then the question "Do the ions move faster than the neutrals?" could be answered. For this particular study, observations were confined to a small portion of the plasma jet's exhaust plume.

EXPERIMENTAL ARRANGEMENT

The radiation which emerges from a point in the jet stream was viewed from two different angles, as illustrated in Figure 1. Spatial resolution was obtained by appropriately masking the image of the source so that light was received only from that portion of the plasma which was under investigation. Mirror (1) was left in place while the spectrum was taken of the radiation which was emitted at 90 degrees with respect to the flow axis. Mirror (1) was then rotated out of the field of view while the spectrum was taken of the radiation which was emitted at 37 degrees with respect to the flow axis.

The JACO f/6.3 spectrograph used is not stigmatic; however, if the fringes were imaged at Sirk's focus this instrument could be made to give a stigmatic image over the 5-inch field used. Since the spectrograph was not used at full aperture, the exposure times for the two runs reported here were much longer than would have been required for normal

## Measurements of Jets Velocities

usage of this instrument. The exposure time is a function of the brightness of the source, the speed of the spectrograph, the optical system, and the film, and under proper conditions the time can be made less than 1 second. However, since the plasma jet operates in a steady state no attempt was made to shorten the exposure times.

The gas used for both runs was argon. The arc current, average chamber pressure, and exposure time for Run I was 282 amps, 20.1 mm Hg, and 5 minutes, respectively. For Run II these values were 356 amps, 12.2 mm Hg, and 7 minutes.

### RESULTS AND DISCUSSION

Using the spectra obtained, velocities were computed as follows. A decrease in wavelength  $\Delta\lambda$  causes each fringe circle of diameter  $d$  to change by an amount  $\Delta d$  such that  $d\Delta d$  is constant for every fringe in the pattern. Therefore,  $\Delta\lambda$  is proportional to  $d\Delta d$ , but since the shift of the fringes is less than the fringe width it is necessary to take two spectra and to compare the diameters of corresponding fringes in the two patterns to determine the fringe shift and the wavelength shift.

The velocity was determined from each pair of lines from these spectra by the following (2):

$$\frac{\lambda_s}{\lambda_u} = \frac{\frac{8f^2}{\Delta d_u^2} + \frac{d_u^2}{\Delta d_u^2}}{\frac{8f^2}{\Delta d_s^2} + \frac{d_s^2}{\Delta d_s^2}}$$

and

$$V \cos \theta_1 = \frac{\lambda_u - \lambda_s}{\lambda_u} \quad 3 \times 10^8 \text{ msec},$$

where the subscripts  $s$  and  $u$  refer to the shifted and unshifted line,  $f$  is the focal length of the lens which images the fringes,  $\Delta d^2$  is the square of the average distance between the fringes,  $d_1^2$  is the square of the diameter of the first fringe, and  $\lambda$  is the wavelength. It should be noted that shifts due to pressure, the Stark effect, or any other factors which are not velocity dependent are the same for both  $\lambda_u$  and  $\lambda_s$ , and are thus accounted for when  $\lambda_u - \lambda_s$  is measured. Extreme care and accuracy must be exercised in making the spectra and in measuring the interference patterns, but a fairly accurate velocity value can be obtained from just one spectral line.

A velocity of 2990 meters per second with a standard deviation of 9 percent and a probable error of 6 percent was determined for Run I from seven argon lines. A velocity of 1880 meters per second with a standard deviation of 8 percent and a probable error of 5 percent was

derived for Run II from five argon lines. The spectra of the interference fringes for Run II are shown in Figure 2, which also indicates the argon lines which were used to measure the wavelength shifts. It should be noted that lines of elements other than argon could have been chosen if desired.

Apparently, this technique could be applied, or could be expanded to apply, to purposes other than simple velocity measurements. It would be very useful for checking the validity of the assumptions used in other methods and as a calibration procedure for checking their absolute values. It could also be useful when detailed information about various components of the plasma is desired. With this technique it would be possible to determine velocity profiles for the plasma by superimposing an image of the plasma jet and a system of interference fringes on the spectrograph slit and then performing Abel-like transformations. Such transformations would involve not only the intensities and line profiles, but would also have to consider the fact that some of the radiation would necessarily be emitted from other than a circularly symmetric plasma cross section. The procedure would be quite complicated, and was not of interest or attempted in this particular study.

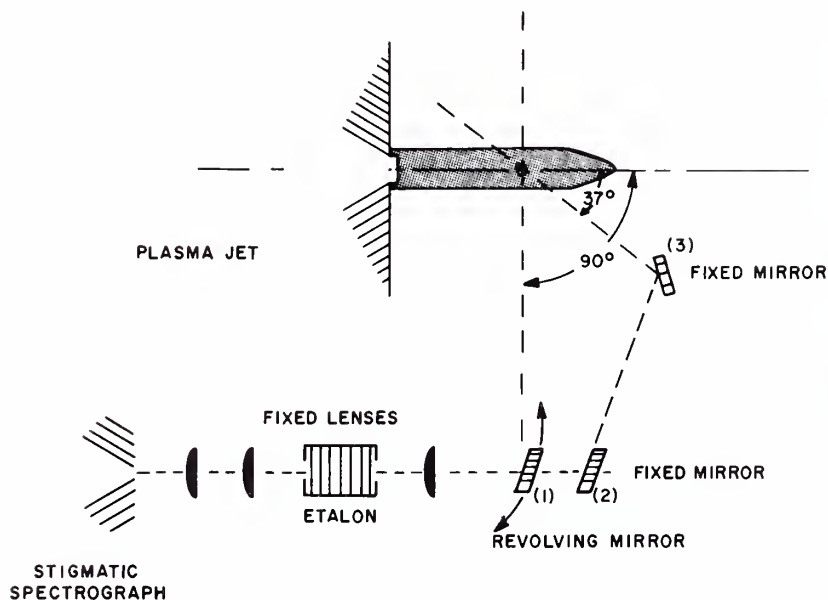


FIGURE 1. Experimental arrangement for velocity measurements.

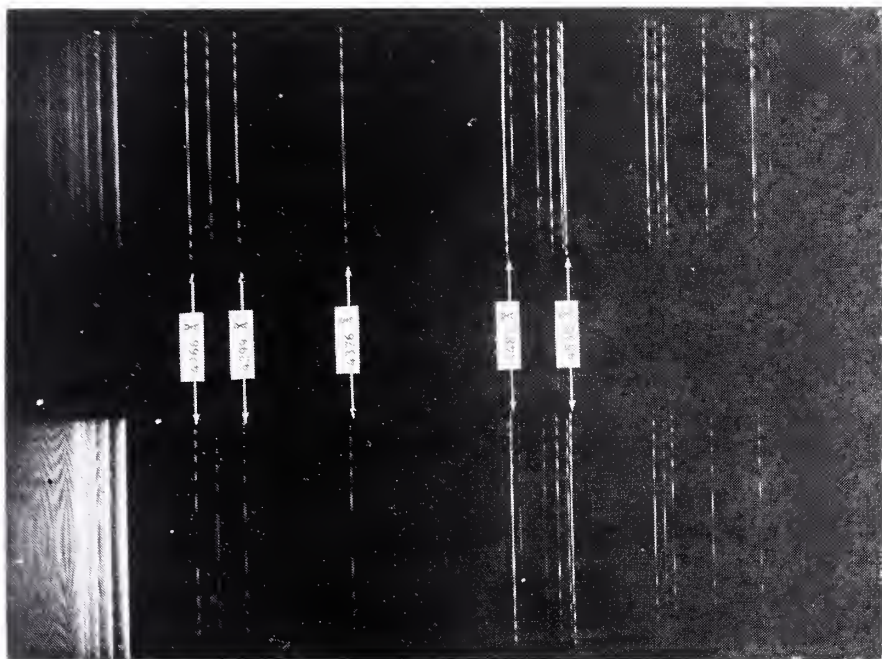


FIGURE 2. Spectra showing the interference fringes - Run II.

#### LITERATURE CITED

1. Baker, D. A., and J. E. Hammel. 1962. Demonstration of classical plasma behavior in a transverse magnetic field. *Phys. Rev. Letters* 8:157-158.
2. Bundy, R. P., and H. M. Strong. 1949. Third symposium on flame and explosion phenomena. The Williams and Wilkins Co., New York.
3. Candler, C. 1951. Modern interferometers. Hilger and Watts, Ltd., Hilger Division, London.
4. Cason, C. 1965. Gas velocity probe for moving ionized gases. *J. Appl. Phys.* 36:342-347.
5. Freeman, M. P., S. U. Li, and W. V. Jaskowsky. 1962. Velocity of propagation and nature of luminosity fluctuations in a plasma jet. *J. Appl. Phys.* 33:2845-2848.
6. Frehs, A. E. 1964. An instrument to measure velocity/electrical conductivity of arc plasma jets. *Am. Inst. Aeron. Astronautics J.* 2:667-673.
7. Thompson, W. B. 1966. An introduction to plasma physics. Addison-Wesley Publishing Co., Inc., Reading, Mass.



A VARIATIONAL PROCEDURE FOR ENERGY EIGENVALUE  
CALCULATION OF NON-RIGID VIBRATORS-ROTATORS

Romas A. Shatas and John D. Stettler  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

A perturbation theoretic procedure for solving the Schrödinger equation of the diatomic vibrator-rotator has been developed as one of the first applications of the wave mechanics (1). Despite this early interest into the vibrator-rotator and many papers written on the subject, a further simplification of the methods used to obtain higher-order corrections to the solution seems feasible and desirable in view of the technological interest in such molecular systems arising from applications in gaseous rotational lasers. In reviewing the vast literature on the subject, one notes that the Wentzel-Kramers-Brillouin method was used first by Dunham (2) to obtain higher order terms of the eigenvalue expansion. A perturbation expansion analysis has been carried out by Kilpatrick (3) who calculated the successive terms of the anharmonic oscillator. Kilpatrick's results are in agreement with the term series formula obtained by Sandeman (4) who extended Dunham's method to higher order terms. Both these approaches, the WKB and the perturbation expansion, are quite laborious and not immediately transparent when the vibration-rotation interaction of a non-rigid rotator must be taken into account. We discuss here an alternate approach (5) based on Hellmann-Feynman and Ehrenfest theorems which, although not extendable to an arbitrarily high accuracy, agrees with the previous results within the presently calculated order. It is rather simple and introduces the vibrational-rotational interaction in a very transparent manner.

The Schrödinger operator for a non-rigidly bonded rotating-vibrating two mass point system can be written in dimensionless form as follows (3):

$$H(q) = -\frac{\partial^2}{\partial q^2} + \gamma^2(q^2 + bq^3) + T(q), \quad (1)$$

where the potential function has been expanded in the Taylor series terminated after the third power in the relative deviation from the equilibrium distance. The dimensionless parameters in Eq. (1) are given by

$$q = \frac{R - R_e}{R_e},$$

where  $R$ , the instantaneous separation of mass points is  $R = R_e(1 + q)$ , and the other dimensionless variables are defined by

$$\gamma = 4\pi^2 \mu k R_e^4 / h^2$$

$$b = 2 B R_e / k,$$

$$A = 8\pi^2 \mu R_e^2 E / h^2, \text{ and}$$

# Procedure for Energy Eigenvalue Calculation

$$T = \frac{j(j+1)}{(1+q)^2} .$$

Therefore, in the dimensionless form, we write the Schrödinger equation for the exact case

$$H_1(q) \Psi_{j,v}(q) = A \Psi_{j,v}(q) . \quad (2)$$

According to Eq. (2), the energy eigenvalues of the system are given by

$$A_{j,v} = \int dq \Psi_{j,v}^* H(q) \Psi_{j,v} \quad (3)$$

Now we make the ansatz that a close approximation to the energy spectrum of A is given by the following prescription: First, displace the equilibrium position of the rigid rotator by  $\rho = \rho(j,v)$ , where  $\rho$  depends upon the rotational (and also the vibrational for the  $b \neq 0$  case) state of the system, and then take the eigenvalue of the Hamiltonian with respect to state vectors of the anharmonic vibrator:

$$A_{j,v} \approx \langle v | H(q + \rho) | v \rangle . \quad (4)$$

The eigenfunctions are now  $\langle q | v \rangle$  where the  $|v\rangle$ 's are the anharmonic oscillator eigenkets

$$\left[ H(q) - T(q) \right] |v\rangle = \left[ -\frac{\partial^2}{\partial q^2} + \gamma^2(q^2 + bq^3) \right] |v\rangle = \epsilon_v |v\rangle . \quad (5)$$

The energy eigenvalues of Eq. (5) in the occupation number representation are given by Eq. (6)

$$\epsilon_v = 2\gamma(n + \frac{1}{2}) + 0(b^2) + \dots . \quad (6)$$

For the purpose of demonstrating our method, we will retain only the first term on the right side of Eq. (6) in the following.

In general, the bond stretch  $\rho$  is small compared with  $q$  and can be calculated from a linear term in  $\rho$  obtained in the energy minimization procedure. However, we must first evaluate the right side of Eq. (4)

$$\begin{aligned} \langle v | H(q + \rho) | v \rangle &= \epsilon_v + \rho \gamma^2 \langle v | 2q + 3bq^2 | v \rangle + b \gamma^2 \rho \\ &+ \rho^2 \gamma^2 (1 + 3b \langle v | q | v \rangle) + \langle v | T(q + \rho) | v \rangle . \end{aligned} \quad (7)$$

By the minimization procedure<sup>1</sup> for the energy, the value of  $A(\rho)$  must be an extremum for the stationary state of the system, therefore

<sup>1</sup>Gora, E. K. 1967. Research directed towards the study of far infrared absorption contours, Report AFCRL-67-0482 (unpublished).

$$\frac{\partial}{\partial \rho} A(\rho) = 0 ,$$

where  $A$  is given by Eq. (3) exactly or, according to our ansatz, by Eq. (4) approximately. Now we recall that the differential form of the Hellmann-Feynman theorem states: If the operator  $H_{\alpha}(q)$  satisfies the Schrödinger equation  $H_{\alpha}(q) \Psi(\alpha, q) = E_{\alpha} \Psi(\alpha, q)$ , then the energy eigenvalue variation of this Hamiltonian between the exact eigenfunctions is given by

$$\frac{\partial E_{\alpha}}{\partial \alpha} = \int dq \Psi^{*}(\alpha, q) \frac{\partial H_{\alpha}(q)}{\partial \alpha} \Psi(\alpha, q) .$$

We now apply this theorem to Eq. (4), although the anharmonic oscillator eigenkets are only good approximations to the exact state vectors of the Hamiltonian  $H(q + \rho)$ . This leads to the expression

$$\frac{\partial E}{\partial \rho} = 0 = \langle v | \frac{\partial}{\partial \rho} H(q + \rho) | v \rangle . \quad (8)$$

On the other hand, the Ehrenfest theorem states that

$$\frac{d}{dt} \langle P(q) \rangle = - \langle \frac{\partial H}{\partial q} \rangle ; \text{ since in our case the momentum is conserved,}$$

$\frac{d}{dt} \langle P \rangle = 0$  and we obtain the condition

$$\langle v | \frac{\partial}{\partial q} H(q + \rho) | v \rangle = 0 \quad (9)$$

Actually, since  $q$  and  $\rho$  are collinear, the statements (8) and (9) are identical.<sup>2</sup>

Partial differentiation of Eq. (7) with respect to  $\rho$  and an auxiliary evaluation of the term

$$\gamma^2 \langle v | 2q + 3bq^2 | v \rangle < 0(b^2) , \quad (10)$$

enables us to deduce (6) that the bond stretch of the non-rigid vibrator is given by

$$\rho = \frac{j(j+1)}{\gamma^2} + \frac{3j(j+1)}{4\gamma^4} \epsilon_v(4+3b) - \frac{3[j(j+1)]^2}{\gamma^4} , \quad (11)$$

<sup>2</sup>Shatas, R. A. 1968. A perturbation theoretic calculation of eigenfunctions and energy eigenstates of the symmetric linear diatomic anharmonic non-rigid rotator-vibrator, Trans. 13th Conf. Army Mathematicians, ARO-D Report 68-1 (unpublished).

## Procedure for Energy Eigenvalue Calculation

where only the terms in first order in  $\epsilon_v$ ,  $b$  and  $j(j+1)\epsilon_v$ , and up to second order in  $j(j+1)$  have been retained. Expanding  $T(q + \rho) = j(j+1)(1 + q + \rho)^{-2}$  in binomial series up to fourth power, and putting it together with the value of  $\rho$  in Eq. (11) into (7), yields the expression

$$\begin{aligned} \langle v | H(q + \rho) | v \rangle = \epsilon_v \left[ 1 + \frac{3}{2} \frac{j(j+1)}{\gamma^2} (1 + b) \right] \\ + j(j+1) \left[ 1 + \frac{15}{18} \frac{1}{\gamma^2} + \frac{7}{4} b/\gamma^2 \right] - \left[ j(j+1)/\gamma \right]^2 \end{aligned} \quad (12)$$

Equation (12), within the order of approximation presently carried out in this calculation, is identical with the results obtained by much longer perturbation-theoretic calculations discussed earlier.

### ACKNOWLEDGMENT

The authors would like to thank Professor E. K. Gora for several stimulating discussions.

### LITERATURE CITED

1. Dunham, J. L. 1932. Phys. Rev. 41:721.
2. Fuess, E. 1926. Ann. d. Phys. 80:367.
3. Kilpatrick, J. E. 1959. J. Chem. Phys. 30:801.
4. Sandeman, I. 1940. Proc. Roy. Soc. (Edinburgh) 60:210.
5. Shatas, R. A. and John D. Stettler. 1968. Bull. Amer. Phys. Soc. 13:1707.
6. Stettler, J. D. and R. A. Shatas. 1969. Bond stretch in diatomic vibrotors induced by rotational-vibrational interaction. Internat. J. Quantum Chem. 35: 635.

GOLD MINING IN ALABAMA IN THE TWENTIETH CENTURY

Kenneth R. Johnson  
Department of Social Science  
Florence State University  
Florence, Alabama

Gold mining in Alabama has a long history extending back into the 1830's (Table 1).<sup>1</sup> Nineteenth century gold mining was carried on by placer miners and prospectors working the alluvial deposits in a 3500-square-mile gold field in east central Alabama. Gold mining seemed to offer great promise, but by the close of the century much of the early enthusiasm had disappeared. Between 1880 and 1900 the average annual production of gold in Alabama was about \$4000 and profits were obviously low.<sup>2</sup>

TABLE 1. Estimated value of gold mined in Alabama, 1830-1904.

Year	Amount	Year	Amount
1830-1879	\$365,300	1892	\$ 2,419
1880	1,000	1893	6,362
1881	1,000	1894	4,092
1882	3,500	1895	4,635
1883	6,000	1896	6,495
1884	5,000	1897	8,455
1885	6,000	1898	6,578
1886	4,000	1899	4,766
1887	2,500	1900	2,618
1888	5,600	1901	3,773
1889	2,639	1902	2,938
1890	2,170	1903	4,894
1891	2,245	1904	29,288

Reports in the 1890's strongly maintained that gold could be mined profitably in Alabama, provided adequate capital was invested and the latest and most efficient mining and milling techniques were used.<sup>3</sup>

By the end of the 19th century, gold on or near the surface of the earth was about exhausted. Future mining would involve locating and working rich veins of ore deep in the earth. New problems such as ventilation, drainage, safety, and cutting through extensive rock formations had to be overcome, all of which required extensive capital outlay. Also, in the 19th century gold was separated from other matter and recovered through the use of the gold pan, the sluice trough, and an amalgamation process involving the use of mercury. But gold existing in forms which could be recovered by these methods was nearly exhausted. The gold available to be mined at the turn of the century existed mainly in two forms. The first was oxidized ore, a mixture of gold with iron,

## Gold Mining in Alabama

copper, and other minerals in an oxidized state. It was usually found at or above the water level. The second form was sulphide ore. This ore carried gold in the sulphide of iron, copper, and other minerals and was usually found below the water level. These ores existed mainly in quartz veins which extended deep into the earth. Profitable gold mining depended upon finding and using some effective means of separating the gold from the other elements in the oxidized and sulphide ores.

Some of the more advanced mining and milling techniques began to be used in Alabama in the 1890's. T. H. Aldrich, a mining engineer in Birmingham, organized the Hillabee Mining Company and reopened the Hog Mountain Mine. This mine, situated about 13 miles northeast of Alexander City in Tallapoosa County, had been discovered in 1839. It was closed in 1845 and not reopened until 1896, at which time it was converted from a surface mine into a deep mine. By 1907 it had a vertical shaft of 100 feet with 300 feet of levels and cross cuts. The ore extracted was mainly oxidized and came from what was known as the blue and barren veins. This ore was crushed between two sets of rollers into particles about 1/8 by 1/2 inches, then heated in a revolving kiln at 350 degrees. Other methods of crushing and grinding ores were experimented with, but all were rejected in favor of the coarse crushing. After crushing, ores were treated in a 75 ton cyanide plant which was erected in 1896 especially to extract gold from oxidized ores. Later, a 120 ton cyanide and blanket concentration plant was erected. In the cyanide process, oxidized ores were placed in a cyanide solution which dissolved the gold content of the ore. The gold was later recovered from the cyanide solution by additional steps in the milling process. The early experiments with crushed ores and cyanide leaching treatment resulted in a recovery of only about 50 percent of the gold content of the ores, but by continuous experimentation and adjustment of the methods to the ore, about 90 percent of the gold was being extracted by 1908.<sup>4</sup>

The techniques of mining and milling at Hog Mountain Mine were soon adopted elsewhere. The Gold Ridge Mine in northeast Randolph County near the Georgia line was operated irregularly by the Gold Ridge Mining Company. By 1907 it had a 100 foot inclined shaft cut to the ore veins, and 250 feet of level tunneling was in use. The extracted ores, all above the water level, were oxidized iron pyrites. The Storey Mine in Talladega County was worked at various times. In 1911 it was opened by a 75 foot shaft leading to a vein of oxidized ore. The Gold Log Mine, also in Talladega County, was worked intermittently until it closed in 1918. Other deep mines might have been worked briefly in the early 20th century but production, if any, was slight.<sup>5</sup>

Placer mining companies continued to be active but relatively unproductive in the 20th century. The Gold Ridge Mining Company was active in developing placer mines in Cleburne and Randolph Counties. The Clear Creek Mining Company was also active in Cleburne County near Heflin. Some work was done in the Tallapoosa Mine near Alexander City and at the Holly Mine near Dadeville in Tallapoosa County. The Warwick Mine near Talladega was worked at times and some production was also reported in Chilton County.<sup>6</sup> But despite a great deal of activity by placer miners in the early 20th century, their ineffectiveness can easily be demonstrated. In 1906, placer miners marketed no gold,



probably for the first time since gold was discovered in Alabama. In 1909, they sold only \$69 worth of gold and only \$357 worth in 1910; none was sold by placer miners in 1911.<sup>7</sup> Occasional sales were reported thereafter, but for all practical purposes placer mining in Alabama was an exhausted enterprise by 1900.

Small amounts of gold were recovered as a by-product of other operations. For example, in Clay County the Southern Sulphur Company operated the pyrite mines near Pyriton. Ores produced were sold mainly to sulphuric acid and fertilizer plants, but yielded small amounts of gold and silver at times.<sup>8</sup>

Introduction of deep mining and the cyanide leaching process of treating oxidized ores greatly increased production in the early years of the 20th century (Table 2). In 1904, gold production jumped from its usual level of about \$4000 per year to \$29,300. For the next 11 years, 1904-1914, gold production remained at an all-time high with an annual average sale of slightly above \$25,800. A peak year was 1905, when 2009 oz of gold were mined and sold for \$41,530. But production declined rapidly after 1914. 1919 was probably the first year in the history of Alabama mining that no gold was reported from any source. In the 11 years from 1904-1914, an amount in excess of \$234,000 in gold was mined. Well over 90 percent of this came from the Hog Mountain Mine.<sup>9</sup>

TABLE 2. Gold and silver production in Alabama, 1904-1919.<sup>10</sup>

Year	Ore Mined (tons)	Gold Produced (oz)	Value	Silver Produced (oz)	Value
1904			\$29,288		
1905	16,425	2,009	41,530	336	\$203
1906	8,565	1,137	24,921	124	124
1907	18,400	1,256.9	25,982	439	296
1908	11,174	1,993.4	41,208	282	149
1909	9,886	1,414.4	29,239	212	110
1910	9,763	1,662.2	33,533	268	145
1911	6,360	915	18,916	171	91
1912	5,693	809	16,724	168	103
1913	4,068		11,094	117	57
1914	5,079	575.05	11,970	199	110
1915	1,250		5,243	12	6
1916					
1917		109.42	2,262	11	9
1918		38.55	797	2	2
1919	None	None	None	None	None

The gold content of ore taken from Alabama mines varied greatly and therefore was watched carefully by the miners. In 1908 each ton of ore yielded about \$1.41 in gold, and in 1910, the yield was about \$3.41 per ton.<sup>11</sup> The yield during other years ranged between these two extremes.

## Gold Mining in Alabama

The silver content of ore was also carefully watched. Silver was never a primary motive for mining in Alabama. It was mainly a by-product of gold mining; therefore, the amount of silver produced was always closely related to the amount of gold mined. Between 1904 and 1914, about 2516 oz of silver were produced. The price of silver fluctuated according to the supply and the demand of the commercial market. In 1907, an oz of silver was worth only 66¢; an oz of gold was worth slightly over \$20.67.<sup>12</sup> These early years in the 20th century were probably the most profitable in gold mining history in Alabama.

Conditions became increasingly unfriendly to the gold miners. During World War I, the cost of labor and materials increased rapidly. More important, the amenable oxidized ores were about depleted, and no effective method for milling the sulphide ores had been developed. Operations at the Hog Mountain Mine ceased in 1916. All the other deep mines were closed by 1919.<sup>13</sup>

Gold mining commanded little interest in the 1920's. Only 14.23 oz of gold were produced in 1920 and 5.51 oz in 1923. These amounts, produced by prospectors in Chilton and Cleburne Counties, were valued at \$410.<sup>14</sup> Although no further production was reported until 1929, opportunities did exist. In 1926, the Alabama Geological Survey reported that the Alabama gold field offered inducements to capitalists,

" . . . since there are very extensive deposits of ore, low grade it is true, but of such extent and so easily and cheaply mined and milled that there seems to be little doubt of the results if the working be done on sufficiently large scale and with the most improved methods and those best adapted to the character of the ores."<sup>15</sup>

General prosperity reigned in 1926, and no investors were eager to enter the field of gold mining in Alabama.

The depression beginning in 1929 brought many conditions which encouraged a revival of gold mining. High unemployment insured a plentiful supply of cheap labor. For example, one mining company in the 1930's paid miners from \$2.75 to \$3.25 for a nine-hour work day and other workers from \$2.00 to \$2.75 per day.<sup>16</sup> The price of mining and milling machinery was correspondingly low. Nevertheless, large amounts of capital were needed; investors were willing to risk their money in gold mining because depression conditions reduced profitable investment opportunities elsewhere. Finally, in 1933, President Franklin D. Roosevelt adopted a policy of inflation which brought a drastic increase in the price of gold. Acting under the authority of the Gold Reserve Act of 1934, he fixed the price of gold at \$35 per oz. While this action was not intended to encourage gold mining, it had that effect.

These conditions stimulated a revival of placer mining. During the depression years, 1929-1939, placer miners and prospectors were active in most counties where gold had once been mined (Table 3). They were most active and most successful in Cleburne, Clay, Randolph,

Tallapoosa, and Talladega Counties. But the inadequacies of placer mining were again demonstrated by the fact that in the best year only 21.77 oz of gold, valued at \$450, were produced.<sup>17</sup> In most depression years, placer miners sold only a few oz of gold and in some years none at all.

The depression also brought a revival of lode mining. In 1932, the W. F. Pasley Mine near Alexander City was reopened. About 100 tons of oxidized ore were treated in a cyanide plant and yielded \$1423 worth of gold and 10 oz of silver. The following year, production at this mine dropped to a mere \$82.<sup>18</sup> The Gold Log Mine in Talladega County was operated for a short time in 1938 by the Guy S. Amos Mining Company, but production was very slight.<sup>19</sup>

Another and probably the largest single gold mining effort ever made in Alabama was also under way. In 1931, P. S. Gardner and George M. Brown began to explore the possibilities of profitably working the old Hog Mountain Mine. Extensive sampling and metallurgical tests on the sulphide ores were made locally and by the American Cyanide Company of New York. Encouraging results of these tests led to formation of the Hog Mountain Mining and Milling Company, with P. S. Gardner of New York as president. The company leased the mine from the Hillabee Mining Company, brought in expensive equipment, and hired a labor force. Operations began in February 1934 with Brown as general manager and Neal O. Johnson as mining engineer. The mine was opened by a 215-foot double compartment shaft, and about 2,000 feet of drifts were run in 1934. The sulphide ore taken from the mine was below the water level and usually contained from 0.18 to 0.22 oz of gold per ton. The ore, once out of the mine, was treated in a 100 ton all flotation mill which was the first of its kind operated in the Alabama gold field. This flotation mill did not separate gold from ore but eliminated much of the waste material, thus forming a concentrate which was then shipped to the Nichols Copper Company for final processing. The concentrate usually yielded from 2.65 to 3.13 oz of gold and 0.5 oz of silver per ton. When the Hog Mountain Mine was reopened, production in Alabama soared, making it the leading gold producer of the Appalachian states. Alabama's production reached a peak in 1936 when 4726 oz of gold valued at \$165,410 were produced. The great majority of this gold came from the Hog Mountain Mine; it was by far the richest gold mine in Alabama.<sup>20</sup>

TABLE 3. Gold and silver production in Alabama, 1929-1939.<sup>21</sup>

Year	Ore Mined, (tons)	Gold Produced (oz)	Value	Silver Produced (oz)	Value
1929	None	9.82	\$ 203	1	\$1
1930	None	21.77	450	3	1
1931	None	19.69	407	3	1
1932	100		1,423	10	
1933			82	None	None
1934	22,511	2,780.71	97,186		
1935	15,067	2,227.24	77,953	401	

# Gold Mining in Alabama

TABLE 3. Continued

1936	30,829	4,726	165,410	869	673
1937	20,173	2,459.89	86,096	457	
1938	300	41	1,435	4	3
1939	10	3	105	None	None

Despite high production and favorable conditions, operations of the Hog Mountain Mining and Milling Company were unprofitable. The mine was closed in May 1937 and the equipment sold.<sup>22</sup> By the end of the 1930's, all mines in Alabama were closed. Increasing costs and low-grade ore simply made mining and milling operations unprofitable.

In the 1940's, only 40.30 oz of gold were sold.<sup>23</sup> This was produced almost entirely as a by-product of other activities.

Gold mining in Alabama was always a minor economic enterprise. Between 1830 and 1950 about 49,495 oz of gold were produced in Alabama.<sup>24</sup> This amount was adequate to stimulate hopes and dreams of all kinds of men through the years. Unfortunately it was not sufficient to satisfy their appetites for wealth and profits.

## FOOTNOTES

<sup>1</sup>Robert A. Russell. Gold Mining in Alabama Before 1860. The Alabama Review, X:(January, 1957), pp. 5-13.

<sup>2</sup>U. S. Department of the Interior, U. S. Geological Survey. Mineral Resources of the United States. 1914 (Washington, D. C.: Government Printing Office, 1915), pt. 1, p. 142. This was an annual publication of the U. S. Geological Survey in the U. S. Department of Interior through 1923, after which it was published by the Bureau of Mines in the U. S. Department of Commerce through 1931. It will hereinafter be referred to by title, date, and page number only.

<sup>3</sup>Thomas M. Owens. History of Alabama and Dictionary of Alabama Biography. (Chicago: The S. J. Clark Publishing Company, 1921), I, p. 660. William B. Phillips. A Preliminary Report on a Part of the Lower Gold Belt of Alabama. Geological Survey of Alabama Bulletin no. 3 (Montgomery: Smith, Allred and Company 1892), p. 34. William M. Brewer. Upper Gold Belt of Alabama. Geological Survey of Alabama Bulletin no. 5 (Montgomery: Joseph P. Armstrong, Printer, 1896) Walter B. Jones. Index to the Mineral Resources of Alabama. Geological Survey of Alabama Bulletin no. 28 (Birmingham: Birmingham Printing Company, 1926), pp. 132-37.

<sup>4</sup>Owens. History of Alabama, III, p. 16. Mineral Resources of the United States, 1906, p. 299; 1907, pp. 557-58; 1908, pp. 651-52; 1909, pp. 538-39; and 1914, pp. 148-49.

<sup>5</sup>Charles A. Abele (comp.) Statistics of the Mineral Production. Geological Survey of Alabama Bulletin no. 13 (Montgomery: Brown Printing Company, 1913), p. 35. Mineral Resources of the United States, 1907, pp. 557-58; 1908, p. 651; 1910, p. 680; and 1918, p. 213.

- <sup>6</sup>Abele. Statistics of the Mineral Production. p. 35. Mineral Resources of the United States, 1905, p. 299, and 1919, p. 213.
- <sup>7</sup>Mineral Resources of the United States, 1909, pp. 538-39, and 1910, p. 680.
- <sup>8</sup>*Ibid.*, 1908, p. 651.
- <sup>9</sup>Abele. Statistics of the Mineral Production, p. 28. Mineral Resources of the United States, 1908, p. 650, and 1910, pp. 678-80.
- <sup>10</sup>Compiled from Mineral Resources of the United States, 1904-1919.
- <sup>11</sup>Mineral Resources of the United States, 1908, p. 650, and 1910, pp. 678-80.
- <sup>12</sup>*Ibid.*, 1907, p. 111.
- <sup>13</sup>N. O. Johnson. Mining and Milling Methods and Costs, Hog Mountain Gold Mining and Milling Company, Alexander City, Alabama. Bureau of Mines U. S. Department of the Interior, Information Circular no. 6914, p. 3.
- <sup>14</sup>Mineral Resources of the United States, 1920, pp. 8-9, and 1923, p. 137.
- <sup>15</sup>Jones. Index to the Mineral Resources of Alabama. p. 137.
- <sup>16</sup>Johnson. Mining and Milling Methods and Costs, Hog Mountain Gold Mining and Milling Company, p. 22.
- <sup>17</sup>Mineral Resources of the United States, 1929, p. 76; 1930, pp. 1920 and 1931, pp. 3-4. U. S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1938, p. 289. The Minerals Yearbook was published annually between 1932 and 1950 inclusively. The 1932-33 edition was published by the Bureau of Mines, U. S. Department of Commerce. Thereafter it was published by the Bureau of Mines in the U.S. Department of the Interior. Hereinafter it will be referred to by title, year, and page number only.
- <sup>18</sup>Minerals Yearbook, 1932-33, p. 148, and 1934, p. 194.
- <sup>19</sup>*Ibid.*, 1939, p. 317.
- <sup>20</sup>C. J. Coley. The Climax of Gold Mining in Alabama. (a paper read at the Alabama Historical Society meeting, Mobile, Alabama, May 5, 1967), p. 4. Johnson. Mining and Milling Methods and Costs, Hog Mountain Gold Mining and Milling Company, pp. 3-16. Minerals Yearbook, 1935, p. 242, and 1937, pp. 344, 349.
- <sup>21</sup>Compiled from the Mineral Resources of the United States 1929-1931 and the Minerals Yearbook, 1932-1939.
- <sup>22</sup>Minerals Yearbook, 1938, p. 289.
- <sup>23</sup>Compiled from the Minerals Yearbook, 1940-1949.
- <sup>24</sup>Minerals Yearbook, 1950, p. 1468.

## Confederate Military Prisons

### CONFEDERATE MILITARY PRISONS: GOVERNOR HENRY T. CLARK'S ROLE IN ESTABLISHING THE FIRST PERMANENT MILITARY PRISON AT SALISBURY, NORTH CAROLINA

Garry C. Mercer  
Jefferson State Junior College  
Birmingham, Alabama

On July 7, 1861, Henry Toole Clark assumed the office of Governor of North Carolina. John W. Ellis, elected Governor in 1858, died on this date and due to his position as Speaker of the Senate, Clark was elevated into the executive chair. One of the most perplexing problems of Governor Clark's administration, aside from raising and equipping troops, was the prison and prisoner of war problem. The state found itself with war prisoners in the state very early in the war and then offered sites in North Carolina for prisons in order to relieve the state of Virginia.

Governor Henry Clark dealt effectively with the prison and war prisoner problem in North Carolina. The first war prisoners arrived in Raleigh on July 22, 1861. The 40 or so prisoners were under the command of Lieutenant David H. Todd, half-brother of Mrs. Abraham Lincoln.<sup>1</sup> The prisoners were placed in the custody of Governor Clark. Clark, not wanting to embarrass the Confederate government at this time, assumed full command and placed the prisoners under the guard of a volunteer company. The people of the city were annoyed because the prisoners were held in a "house" inside the city limits.<sup>2</sup>

All supplies, finances, and food had to be supplied for each prisoner, since Richmond had furnished none. Clark assumed this responsibility and allowed the prisoners the parole of the town.<sup>3</sup> The prisoners, while being treated fairly, were dissatisfied and in protest signed a petition demanding immediate release which was sent to the Governor.<sup>4</sup>

By July 29, 1861, Governor Clark was tired of the entire affair and proceeded to write Confederate Secretary of War Leroy Walker pointing out that the presence of Union prisoners in Raleigh was interfering with the Confederate recruitment program.<sup>5</sup> Governor Clark also asked that no more Union prisoners be sent to Raleigh and what he should do with those already on hand.<sup>6</sup>

The communication of Clark was effective. The Confederate government in Richmond sent Lieutenant-Colonel Riddick to survey the war prisoner condition and problem in Raleigh and report back to Richmond. The report of Colonel Riddick was one of approval and praise concerning all the measures and actions made by Clark.<sup>7</sup> Although Clark had also requested no new arrivals, several new prisoners arrived in Raleigh from Richmond. An angry Governor Clark dispatched another letter to the War Department demanding an end to the prisoner shipments to the city.<sup>8</sup>

This letter brought immediate response, because on August 8, Secretary Walker ordered Brigadier General Winder, then in command of Richmond



prisoners, to suspend all prisoner shipments to Raleigh, unless upon actual consent of Governor Clark.<sup>9</sup> No further instructions were forthcoming from Richmond concerning war prisoners in Raleigh. Governor Clark had waited patiently during this period of time.

Having received no word from the War Department, on October 25, 1861, Governor Clark moved his prisoners out of the city onto the state fairgrounds located near the city. A volunteer company was placed in charge. As stated before, the Confederate Government provided no clothes or food for the prisoners and therefore Clark did this for the prisoners.<sup>10</sup> Once more Clark took the initiative and wrote the War Department asking for secure winter quarters and a location more suitable and better equipped to handle prisoners of war.<sup>11</sup> In late December, 1861, Clark wrote another letter before the War Department answered by removing the prisoners to Salisbury.<sup>12</sup>

While in and around Raleigh, the prisoners received very favorable treatment from the townspeople. Credit for this lies mainly with Governor Clark since he took it upon himself to see that they were clothed and fed properly.<sup>13</sup> A Union hospital steward named Butler, a regular prisoner of war, stated that the prison at Raleigh had adequate hospital facilities. Ample beds, an excellent surgeon, plus the care given to the sick and wounded made the prison appropriate in Butler's estimation.<sup>14</sup> Clark was under no pressure or obligation to do all this, but the fact that Clark did help speaks for the character of the man.

The prisoners were removed to the Confederate military prison located at Salisbury, North Carolina. Governor Clark played a large role in obtaining this camp, the first permanent war prison in the South.

The importance of Salisbury cannot be overlooked. This was the largest and only permanent military prison located in North Carolina. Why were there not more camps of detention in the State? There are several reasons. One was the presence of Federal Troops in Virginia. Military prisoner of war camps would be unnecessarily close to the areas of fighting if located in North Carolina. Second, food and other supplies were needed for a prison and Confederate officials felt the rich agricultural area of North could best serve General Lee. Third, citizens often complained when military prisons were placed in their vicinities. Fourth, Union sentiment was also strong in many areas of the state.

In June, 1861, Henry T. Clark wrote to the Confederate Secretary of War and informed him that he had taken over the responsibility for locating a prison site in North Carolina. The Confederate War Department had contacted Governor John Ellis before June requesting he select a place, if possible, suitable for the "safekeeping of our prisoners of war".<sup>15</sup> Secretary Walker was interested in the Alamance County area, especially between Hillsboro and Greensboro, where large buildings had been found and where the authorities felt prisoners might be kept at little cost.<sup>16</sup> Governor Clark now reported that all attempts in this area had proved futile and suggested that a site in the town of Salisbury be chosen.

## Confederate Military Prisons

Clark stated that Salisbury possessed railroad facilities, running North, South, and West. He further speculated that supplies would be abundant and available at low cost. "A very large and commodious building"<sup>17</sup> could be purchased for only \$15 thousand, which could easily and safely contain between 1500 and 2000 prisoners of war. After the war Clark stated the same building could be sold for from \$30 to \$50 thousand. The North Carolina Governor went further and assured the Secretary of War that the state would furnish "proper troops for guard purposes."<sup>18</sup>

A few days afterward, the Governor sent Colonel William Johnston, acting as purchasing agent, to Salisbury to investigate the full possibilities of the Salisbury site. Johnston, after a month of surveying, reported to Clark that there was one large brick building formerly used as a cotton factory, three stories high and some 50 by 90 feet in dimension, and construction of good brick. Johnston also reported the availability of six brick tenements with four rooms each, and a large superintendent's house of framed material. Also included in the proposed site, comprising 16 acres inside the city limits of Salisbury, was a blacksmith shop, two inferior buildings, and an engine house attached to the factory building. The area was shaded by a grove of oak trees and contained an adequate supply of good water.<sup>19</sup> After his description of the contents of the site, Johnston explained that the property had once belonged to Maxwell Chambers, a local cotton manufacturer. The property was in the hands of a Mr. D. A. Davis, executor, and was offered for \$15 thousand.<sup>20</sup> The owners stated they would accept Confederate Bonds as payment or lease the property at the rate of \$1000 per year. Colonel Johnston felt it would require another \$2000 to put the site into working order.<sup>21</sup>

Governor Clark, upon receiving Johnston's report, sent it to the Confederate War Department for approval. Secretary Walker, on July 30, 1861, wrote Clark stating that the report was "satisfactory."<sup>22</sup> Walker suggested that Clark purchase the property immediately. He seemed pleased that Confederate Bonds could be used in the proposed sale. Secretary Walker also proposed that Governor Clark stand ready to begin the necessary repairs at once. A guard for the prison site was also mentioned in the correspondence.

Secretary Walker, after the Confederate victory at First Manassas, became anxious to occupy the prison site. Walker urged Clark to hasten preparations to the extent of his ability.<sup>23</sup> At the first opportunity Walker wanted to be notified that the site was ready to receive prisoners. Secretary Walker made no mention, however, of the \$15 thousand needed for the actual sale; therefore, Governor Clark was unable to finalize the purchase or begin any type of preparation.<sup>24</sup>

Changes occurred in the Confederate War Department at this time, with Judah P. Benjamin replacing Leroy Walker as Secretary of War. The plans for a prison camp at Salisbury were either mislaid or forgotten in this change-over. For the next two and one-half months, no correspondence concerning this matter was exchanged.<sup>25</sup> By the end of this delayed period the Confederate War Department was in a desperate situation as the South was receiving an ever-increasing number of war prisoners. These prisoners

had to be located in suitable confines. In the latter part of October, 1861, Secretary Benjamin made appeals to Governor Joseph E. Brown of Georgia and Governor A. B. Moore of Alabama to offer prisoner of war sites. Meanwhile, Governor Clark had grown increasingly impatient with the Confederate officials because they had not delivered the necessary funds to buy the Salisbury site. Clark informed Benjamin that the deal was still pending. Governor Clark, in the same communication, urged the immediate remittance of 15 thousand dollars plus finances needed to renovate the site. The Governor went further and expressed the belief that all that was needed to put the site into immediate operation was a high plank palisade wall to enclose the entire area. A repair of the buildings and grounds would also be necessary but would require little actual work. Once these items were taken care of Governor Clark felt the prison could house immediately 400-500 prisoners.<sup>26</sup>

This communication by Clark was all that Benjamin needed to move into action. Benjamin immediately notified Colonel William Johnston, who made the original survey for the governor, to act as purchasing agent for the Confederate Government. Benjamin instructed Colonel Johnston to reopen purchasing procedures, make the site operational at once, and make the site available to house 2000 prisoners and 80-100 guards. These orders presented Colonel Johnston with a large task since Governor Clark had estimated the site would be able to house no more than 500 prisoners. A man of quick and decisive action, Johnston closed the sale of the Salisbury site with Confederate War Bonds, which he received from a government agent. The site was immediately prepared to house the number of prisoners suggested by Benjamin.

The efforts made by Henry T. Clark in aiding the Confederate government to secure its first permanent prisoner of war camp evidenced ulterior motives. Governor Clark wanted to relocate, as rapidly as possible, the increasing number of prisoners of war in Raleigh. As soon as Colonel Johnston concluded the sale on November 4, 1861, Clark began to badger Secretary Benjamin to allow the prisoners of war in Raleigh to be moved to Salisbury at the first opportunity. Clark pursued his aims by pointing out that 73 prisoners held at Fort Macon needed a permanent confine. In order to hasten the necessary repairs, Governor Clark suggested that the War Department contact D. A. Davis of Salisbury for acquiring aid in obtaining lumber and other supplies for the needed repairs.<sup>28</sup> The War Department apparently followed the suggestions of Governor Clark and the site was soon made ready for occupation by the Federal prisoners.

Before the repairs were actually completed, the first Federal prisoners of war arrived in Salisbury from Raleigh and caused excitement among the townspeople. These were the very first Union soldiers that many had seen.<sup>29</sup> One hundred and seventy-six more prisoners arrived by train in Salisbury on December 29, 1861. In February, 1862, 80 more prisoners arrived. Thus by the middle of March there were around 1500 military and political prisoners located in Salisbury.<sup>30</sup>

Although the repairs were not completely finished when the first prisoners arrived at Salisbury, the prison met with success. The most important problem of the site was the securing of sufficient guards.

## Confederate Military Prisons

Governor Henry Clark assumed the initial responsibility in the summer of 1861, but to his dismay he found that the people of North Carolina would not enlist in units designed for such "degrading service" as the safe-guarding of "Yankee" prisoners.<sup>31</sup> Clark was considerably relieved when around 140 students and faculty members from Trinity College known as "Trinity Guards" volunteered their services. This force was led by their college president, the Rev. Dr. Braxton Craven.<sup>32</sup>

Salisbury Prison had worked out so well that Clark invited the Confederate government to locate a second military prison within the boundaries of North Carolina. Clark had in mind a small academy in Iredell County, called Olin. Governor Clark indicated in correspondence with the War Department that opposition to a military prison in that area had abated. Clark in a report to the Secretary of War stated that the academy was located about 12 miles from Statesville, which was on the Western North Carolina Railroad, and that the site contained a large building, 50 by 80 feet and three and one-half stories high, plus two other large frame houses and 10 acres of land. The price, as quoted by Henry Clark, was very cheap, only \$500 for the buildings, plus a small charge for the grounds. Supplies needed to equip and feed such a venture were abundant.<sup>33</sup> Governor Clark offered a second site in order to aid the Confederate Government in locating war prisoners. The entire Olin Academy was eventually dropped for some reason by the War Department at Richmond. It was opened two years later as a co-educational high school.<sup>34</sup>

By April, 1862, Governor Clark had completely changed his whole outlook in regard to the military camps in North Carolina. Clark expressed the desire to disband the prison at Salisbury due to the supply problem.<sup>35</sup> Adding to the Governor's change in attitude was the growing discontent of the people with the military prisons and the Confederate Government in that area of the state.

An exchange of prisoners in May, 1862, helped the problem since only a few officers and political prisoners remained.<sup>36</sup> After this initial exchange the importance of Salisbury Prison declined steadily. By May, 1863, saw fewer than 25 prisoners still detained there, the rest being paroled or exchanged, or sent as enlistments in the Confederate Army. The remaining prisoners were the "worst, most inveterate cases."<sup>37</sup> For an extended period of time after May, 1863, Salisbury Prison almost went out of existence. In October, 1864, General U. S. Grant ordered no more prisoner exchanges and Salisbury began to thrive again. This move on the part of the Northern high command meant that the Confederate States faced a prison shortage. Salisbury, and other prisons in the South, were sent large numbers of prisoners until overcrowding became a problem. This problem of overcrowding continued to grow worse as the war progressed. August 24, 1864, saw a new commander for Salisbury Prison in Major John H. Gee of the 11th Florida Regiment. Gee was chosen to command Salisbury due to his record as an organizer and administrator. When Major Gee arrived at the prison he found a prison which in his estimation should contain 2500 prisoners having a total prisoner population of 9,000. With the overcrowded prisons and understaffed administrative units at the prisons, conditions grew worse. The problem of guards plagued Salisbury after the increase in prisoners. The prison commanders found that one-half of the guards were called to



the battle front in Virginia. Less pay and equipment were issued to prison guards so this tended to make this type of service less attractive. The issue of rations at best was irregular and this caused discontent. The quality of guards declined until by late 1864 and early 1865 Junior and Senior Reserves were serving as guards.

Several of the prisoners who survived these severe conditions later wrote vivid accounts of their experiences. Two of the most famous accounts of this type were authored by Junius H. Browne and Albert D. Richardson.

Junius Browne in describing his stay at Salisbury began on a hopeful note. The reason for Mr. Browne's hope upon first reaching Salisbury was the fact that the prisoners were given the "privilege of the yard."<sup>38</sup> Exercising in the open air was a luxury for most prisons and games were even played by the prisoners. This attitude quickly changed, however, as Browne became more familiar with Salisbury. The room in which he stayed was described in his account as "hung round with vermin, which the wretched inmates used as clothes and bed covering. . . no light of any kind was furnished us."<sup>39</sup> Mr. Browne closed his account by stating that he felt himself unable to describe adequately the "repulsiveness and superlative squalor" of Salisbury.<sup>40</sup>

Albert Richardson, appearing before the Committee on the Conduct of the War, stated that he arrived at Salisbury Prison on February 3, 1864, and remained there until his escape on December 18, 1864. Richardson stated further that for months Salisbury was the "most endurable prison" he had seen with the prisoners being "comparatively well fed and kindly treated."<sup>41</sup> Then in October, 1864, several thousand regular prisoners of war arrived and Salisbury changed "into a scene of cruelty and horror. . ."<sup>42</sup> Prisoners, Richardson stated, often went 24-48 hours with no food of any type.

The cases of these prisoners seem to indicate that as long as the prisoner population was low the care and food they received were adequate. After October, 1864, the conditions grew worse mainly due to overcrowding. It must be remembered that the war was drawing to a close and supplies as well as personnel were low. In Salisbury, as in other Southern prisons the main cause of death was diseases such as typhoid and scurvy. Diarrhea, insanity, and blindness were also common among the prisoners. A report of a Captain Louis R. Fortescue summed up the case for Salisbury: "the long continued filthy and crowded condition here, with foul and insufficient water, the constant exposure to the burning sun and chilling dew, with scant and insufficient clothing, and without shelter, the great scarcity of fuel for warming and cooking purposes, the inferior quality of food, the almost total absence of vegetable diet, together with harsh personal treatment, causing great bodily suffering and mental anxiety, all combined to induce and aggregate these diseases."<sup>43</sup> The officials in Richmond realized that the prisons were badly in need of improvements and supplies. Samuel Cooper, Adjutant-General and Inspector General of the Confederate Army, sent his assistant, General T. W. Hall to Salisbury for an on-site inspection of the conditions which existed there. The final report of General Hall was made in February, 1865, and stated in

## Confederate Military Prisons

part: "That they have not received the full amount of fuel due them during a season of more than ordinarily inclemency I think is chargeable more probably to want of energy on the part of the post quartermaster, Captain J. M. Goodman. . . ."44 This inspection and report came in the closing months of the war so no improvements were made.

We find then that the Salisbury Prison during the Clark administration while not an ideal or perfect place of detention, nevertheless, was better than it was to become. Why did the Salisbury become infamous after the administration of Clark? It has been mentioned before that as the war progressed the shortages grew more acute. Clark had mentioned shortages as early as 1862. Confederate officials were more interested in supplying and feeding troops than prisoners. As more troops were called to the areas of fighting, the number of guards left at the prison had to use methods that were somewhat harsher than had been necessary before.

The blame for the conditions inside Salisbury cannot be laid upon the shoulders of Governor Clark nor later upon the shoulders of Governor Zebulon Vance for it must be remembered that Salisbury "was administered exclusively by Confederate officials."<sup>45</sup> Clark could be blamed for obtaining the prison or allowing the prison in the state in the first place, but not for the conditions which existed there later.

### FOOTNOTES

<sup>1</sup>Official Records, Series 2, 111, p. 695; Mack Trent. Civil War Prisons and Prisoners in North Carolina, 1861-1865, unpublished master's thesis, East Carolina College, (1961), p. 17.; William Best Hesselstine, Civil War Prisons: A Study in War Psychology (1930), p. 57.

<sup>2</sup>Official Records, Series 2, 111, p. 696-697.

<sup>3</sup>Official Records, Series 2, 11, p. 695; Trent. Civil War Prisons, p. 18.

<sup>4</sup>Official Records, Series 2, 11, 695-697.

<sup>5</sup>*Ibid.*

<sup>6</sup>Official Records, Series 2, 11, p. 695-697.

<sup>7</sup>*Ibid.*, p. 699.

<sup>8</sup>Official Records, Series 2, 11, p. 1372.

<sup>9</sup>*Ibid.*, p. 700.

<sup>10</sup>*Ibid.*, p. 695-732; Robert H. Kellogg. Life and Death in Rebel Prisons (1867), p. 387.

<sup>11</sup>Official Records, Series 2, 11, p. 732.



- <sup>12</sup>*Ibid.*
- <sup>13</sup>Official Records, Series 2, 111, p. 695-732.
- <sup>14</sup>*Ibid.*
- <sup>15</sup>Official Records, Series 2, 111, p. 681; Hesselstine. Civil War Prisons, p. 55; Trent. Civil War Prisons, p. 35.
- <sup>16</sup>Official Records, Series 2, 111, p. 681-682.
- <sup>17</sup>*Ibid.*
- <sup>18</sup>*Ibid.*
- <sup>19</sup>Official Records, Series 2, 111, p. 694; Hesselstine. Civil War Prisons, p. 62.
- <sup>20</sup>Official Records, Series 2, 111 p. 692-695.
- <sup>21</sup>*Ibid.*, p. 696.
- <sup>22</sup>*Ibid.*, p. 702.
- <sup>23</sup>Official Records, Series 2, 111, p. 702.
- <sup>24</sup>*Ibid.*
- <sup>25</sup>*Ibid.*
- <sup>26</sup>Official Records, Series 2, 111, p. 702.
- <sup>27</sup>Official Records, Series 2, VIII, p. 675; Trent. Civil War Prisons, p. 56.
- <sup>28</sup>Official Records, Series 2, 111, p. 738.
- <sup>29</sup>Clark. Histories of Regiments, IV, p. 746.
- <sup>30</sup>*Ibid.*
- <sup>31</sup>Official Records, Series 2, 111, p. 693.
- <sup>32</sup>Nora Campbell Chaffin, Trinity College, 1839-1892, (1950), p. 223.
- <sup>33</sup>Official Records, Series 2, 111, p. 767.
- <sup>34</sup>Salisbury Carolina Watchman, February 14, 1864.
- <sup>35</sup>Official Records, Series 2, 111, p. 855.
- <sup>36</sup>Salisbury Carolina Watchman, May 25, 1862; The Stars and Stripes in Rebellion, A Series of Papers Written by Federal Prisoners in Richmond, Tuscaloosa, New Orleans, and Salisbury, North Carolina (1962), p. 125.

## Confederate Military Prisons

<sup>37</sup>Salisbury Carolina Watchman, May 4, 1863.

<sup>38</sup>Junius Henri Browne. Four Years In Secession: Adventures within and Beyond the Union Lines: Embracing a Great Variety of Facts, Incidents, and Romance of the War (1865), p. 315.

<sup>39</sup>Willard W. Glazier. The Capture, the Prison Pen and the Escape, Giving an account of Prison Life in the South, Principally at Richmond, Danville, Macon, Savannah, Charleston, Columbia, Mellin, Salisbury and Andersonville; Describing the arrival of Prisoners, Plans of Escape, with Incidents and Anecdotes of Prison Life; Embracing also, the Adventures of an Escape From Columbia, South Carolina, Recapture, Trial as a Spy, and Final Escape from Sylvania, Georgia (1866),. p. 309.

<sup>40</sup>Glazier, The Capture, The Prison Pen, p. 308.

<sup>41</sup>Glazier, The Capture, The Prison Pen, p. 304.

<sup>42</sup>*Ibid.*

<sup>43</sup>Pennsylvania at Salisbury, North Carolina--Ceremonies at the Dedication of the Memorial Erected by the Commonwealth of Pennsylvania in the National Cemetery at Salisbury, North Carolina (1901), p. 57.

<sup>44</sup>Official Records, Series 2, VIII, p. 39; Report of General T. W. Hall to General Samuel Cooper, Adjutant and Inspector General of the Confederate Army.

<sup>45</sup>Trent. Civil War Prisons, p. 6.

RECOVERY OF A 13-INCH SEA COAST MORTAR  
FROM BALDWIN COUNTY, ALABAMA

Thomas A. McMillan and Harold O. Beals  
Department of Forestry  
Auburn University, Auburn, Alabama

The recovery of an eight-and-half ton Sea Coast Mortar tube was culminated July 4, 1967, after three days of intensive work. The gun was located following several weeks of searching in a small canal leading off the Tensaw River in Baldwin County a few miles north of the Mobile Bay Causeway in the head waters of the Bay. It was submerged under about 5 feet of water and several feet of mud about a mile north of Fort Huger, where the mortar is thought to have been located before being washed to the point of salvage by the hurricane of 1906.

The mortar tube was winched up and out of the mud with a Caterpillar tractor on a steel barge and towed several miles under water to a place where it could be beached. The mortar had rested on a large wooden raft but no attempt was made to raise the raft or to locate the gun carriage.

The mortar was in remarkably good condition and showed only slight pitting (Fig. 1). Because it had been exposed to salt water, it was necessary to soak it for several weeks in a caustic solution before priming and painting it.

The following markings were found on the tube:

"17,200 lbs. No. 53 L. S. B."  
"Fort Pitt, Pa. 1862"

and mean: 17,200 lbs-weight of the mortar tube; No. 53 - registry number; L.S.B. - Lt. L.S. Babbit (inspector); Fort Pitt, Pa. - foundry where the tube was cast; 1862 - records show the tube was inspected Feb. 4, 1862.

Also in raised lettering on the side of the tube was the number 840 which was the foundry number. The trunions did not have any markings. Dimensions of the tube were 43 inches in diameter and 55 inches in length. The bore was 13 inches in diameter and 35 inches deep.

The 13 inch mortar was the largest piece of ordnance in the Civil War and was used primarily for sea coast fortifications but some were placed in mortar boats for seige operations. The most famous of the 13 inch mortars was the "Dictator" used in the seige of Petersburg and was mounted on a railroad car. The mortar fired an explosive projectile weighing about 220 pounds with a 20 pound powder charge. Sometimes a 700 pound projectile was used with a 75 pound power charge. The maximum range of the 13 inch mortar was about three miles.

The weapon described here was thought to have been used during the seige of Spanish Fort and Fort Blakely in April, 1865. No records of such a weapon in this area were found and several local persons contended that

## Recovery of Sea Coast Mortar

it had been previously captured by the Confederates and emplaced on Fort Huger to shell the Union armies investing the two forts. It is known that Commander Porter had several Union mortar boats in the area. Several 13 inch balls have been found in the battle area over the years.

Records of the battles of these forts are scattered and incomplete. Fort Huger was blown up by the Confederates and was not captured. Photographs of the 13 inch mortar may be found in Miller's *Photographic History of the Civil War*. The National Archives lists a register of 13 inch mortars manufactured at the Fort Pitt Foundry by Knap and Knap and Rudd (now Makintosh-Hemphill) in which 44 mortars were inspected. Of these only one was powder-proofed and it was No. 53.

The salvage operation was reported in the July 6th edition of *The Baldwin Times* and the July 9th edition of the *Mobile Press Register*.



FIGURE 1. 17,200 pound 13-inch Sea Coast Mortar No. 53 recovered July 4, 1967 from Baldwin County, Alabama.

REFERENCES

1. Miller, F. T., The Photographic History of the Civil War, Special Edition, Thomas Yoseloff, Inc. N.Y. 1957. Vol. 1, p. 252, 253, 255; Vol. 3 p. 187; Vol. 5 p. 23, 25, 130, 171; Vol. 6 p. 197.
2. The War of the Rebellion, Records of the Union and Confederate Navies. Government Printing Office, Washington, D. C., Series 1, Vol. 22. 1901.
3. The War of the Rebellion; A compilation of the Official Records of the Union and Confederate Armies. Government Printing Office, Washington, D. C. Vol. 47-49; Series II, Vol. 8. 1901.







26 (76.1) B

THE JOURNAL

OF THE

ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA

VOLUME 41

NUMBER 2

LIBRARY APRIL, 1970

JUN 7 1972

THE AMERICAN MUSEUM



THE JOURNAL  
OF THE  
ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 41

APRIL, 1970

NUMBER 2

EDITOR, PRO TEM.

Robert T. Gudauskas  
Auburn University

ARCHIVIST

Clyde H. Cantrell  
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Ann Everett  
Crossville High  
School

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

## CONTENTS

### ARTICLES

Mammals of Mobile and Baldwin Counties, Alabama Donald W. Linzey . . . . .	64
Propagation of High Intensity, High Voltage Electron Beams T. G. Roberts . . . . .	100
Old China Trade Revisited Curtis T. Henson, Jr. . . . .	110

## Mammals of Mobile and Baldwin Counties

### MAMMALS OF MOBILE AND BALDWIN COUNTIES, ALABAMA

Donald W. Linzey  
Department of Biological Sciences  
University of South Alabama, Mobile, Alabama

#### INTRODUCTION

There has been no previous study of the mammals of Mobile and Baldwin Counties, Alabama, and there are relatively few published records or specimens in collections from these counties. The only previously published accounts including the mammals of southwestern Alabama were by Wallace (30) and Howell (15). Wallace, a biologist with the Alabama Conservation Department, compiled a list of the mammals of Alabama. However, his annotations were of a general nature and contained no definite information as to occurrence in the state. Howell's report was the result of field investigations carried on by the Biological Survey from 1908 to 1916 and included ecological and distributional data on 65 species and subspecies of mammals occurring within the state of Alabama. During the past 50 years, a number of new species and subspecies have been recorded in the state; the ranges of many species have been altered, largely through the activities of man; many taxonomic revisions have occurred; and the distribution of most forms has been much better defined as a result of additional collecting and field work. Furthermore, neither Wallace (30) nor Howell (15) included much data concerning weights, measurements, reproduction, parasites, molt, etc.

Since 1921, the only other works involving mammals of this area have been mainly in the form of published notes, game inventories, and unpublished theses. Thus, a complete and comprehensive survey to determine distribution and abundance of the mammals occurring in Mobile and Baldwin Counties has never been undertaken.

This investigation has resulted in one new state record, 20 new county records, the accumulation of data on nine mammals that were not recorded from this area by Howell (15), and the inclusion of all taxonomic revisions that have occurred since 1921.

#### GENERAL DESCRIPTION OF THE COUNTIES

Mobile and Baldwin Counties are located in extreme southwestern Alabama. The area lies in the humid region of the United States (Lower Austral Life Zone) and is an area of high rainfall, long hot summers, and short mild winters, with only short periods of subfreezing weather.

Mobile County has a total area of 1,226 square miles. The Mobile, Tensaw and Middle Rivers and Mobile Bay form its eastern boundary, and on the south it borders the Gulf of Mexico and Mississippi Sound. The county extends westward to the Alabama-Mississippi state line. Petit Bois and Dauphin Islands, lying from five to twelve miles distant from the mainland, are a part of the barrier reef that encloses Mississippi Sound and are included within the county limits. Exclusive of the islands, the county has a north-south length of approximately 60 miles and east-



west width ranging from 17 miles at the southern end to about 30 miles at the northern end.

The county is marked by two distinct physiographic features. A low, nearly flat or undulating plain extends along the southern and eastern sides and constitutes about one-third of the total area. A high plain rises within a short distance to an elevation ranging from 50 to 100 feet above sea level and beyond this, with a gradual rise to the north and northwest, to a maximum elevation of 352 feet at Citronel. The low plain, owing to the nearly flat surface relief and shallow stream dissection, is occupied by soils of poor or imperfect drainage. The interior, or high plain is, in most places, deeply and thoroughly dissected, giving it a rolling or hilly surface relief (32).

The average annual rainfall for Mobile, Alabama, is 60.67 inches. The average temperature is 68.3 F with a January average of 52.8 F and a July average of 81.6 F (24).

Baldwin County has a total area of 1,613 square miles and is the largest county in Alabama. With the exception of several miles in the extreme northeast bordering Escambia County, it is entirely surrounded by water. It is bounded by the Little River on the north, the Tombigbee, Alabama, Apalachee and Tensaw Rivers and Mobile Bay on the west, the Perdido River and Perdido Bay on the east, and by the Gulf of Mexico on the south. Baldwin County is approximately 75 miles long and ranges between 20 and 40 miles in width (5).

Across the northern half of the county, the foot-hills of the Appalachian system give way to rolling uplands until they reach Mobile Bay. The southern half of Baldwin County is a coastal plain descending gradually to the Gulf of Mexico. Near Fairhope, an area known as Sea Cliff is the highest point (268 feet) on the tide-water between New Jersey and the coast of southern Texas (5).

The average annual rainfall for Bay Minette, Alabama, is 63.23 inches, although Foley, Alabama, receives an annual average of 68.32 inches (24). The average temperature for Bay Minette is 68.1 F, with a January average of 53.1 F and a July average of 81.0 F (24).

Mobile and Baldwin Counties lie within that part of the Gulf Coastal Plain that is made up of unconsolidated noncalcareous marine sands and clays (32). Both counties are in the southern pine belt and were originally heavily forested, principally with longleaf, or yellow pine (*Pinus palustris*). The following discussion of the flora of this area is based upon the description given by Howell (15). In the hill country, the longleaf pine is the prevailing tree. Other typical species include loblolly pine (*Pinus taeda*), turkey oak (*Quercus laevis*), blue jack oak (*Quercus incana*) and huckleberry bushes. In the depressions between the hills and around the heads of numerous streams rising in this area are found many small swamps in which is a dense growth of sweet bay (*Magnolia virginiana*), water oak (*Quercus nigra*), laurel oak (*Quercus hemispherica*), southern black gum (*Nyssa biflora*), white cedar (*Chamaecyparis thyoides*) and pond cypress (*Taxodium ascendens*).

## Mammals of Mobile and Baldwin Counties

An open forest of pines, chiefly the swamp pine (*Pinus elliottii*), is found on the flats along the coast. In the hammocks--slightly elevated tracts rising from the swampy flats--the magnolia (*Magnolia foetida*), beech (*Fagus grandifolia*), holly (*Ilex glabra*), water oak, laurel oak and the live oak (*Quercus virginiana*) occur. A dense growth of shrubs, including the titi (*Cyrilla racemiflora*) and the black titi (*Cliftonia monophylla*) is found along hammock borders and in small swamps.

Extensive river swamps, ranging in width from one to five miles and traversed by numerous stream channels and bayous, cover the delta formed by the Mobile, Middle and Tensaw Rivers. Forests of cypress (*Taxodium distichum*), tupelo gum (*Nyssa aquatica*), black gum, red maple (*Acer rubrum*), water hickory (*Hicoria aquatica*), water oak and overcup oak (*Quercus lyrata*), all heavily festooned with the long Spanish "moss" and hung with tangles of grape vine and other climbing plants, are found here.

Extensive salt marshes, largely occupied by the black rush (*Juncus roemerianus*), occur on the shores of the coastal bays and on the outer islands. There is a considerable forest of pines and hardwoods on Dauphin Island. Lower parts of the Island are given over to rolling sand dunes, and the shores are bordered with extensive mud flats.

### MATERIALS AND METHODS

The original study extended from October, 1967, through June, 1969. Additional data obtained through October, 1971, have been added. The majority of the data concerning small mammals came from a comprehensive trapping program carried out in both counties. A total of 17,319 trap nights were recorded in Mobile County and 9,006 trap nights were recorded in Baldwin County. Trapping was accomplished with standard mouse and rat traps, Museum Special traps, Sherman live traps, mole traps and Hav-a-Hart traps. In most cases, traps were baited with peanut butter. However, when trapping exclusively for shrews, potted meat was substituted as bait. Occurrence of some species in an area was determined by direct observation or by signs such as beaver dams, tracks, etc. A considerable amount of data was obtained from road kills. Some information was obtained from a questionnaire sent to 1,700 members of the Mobile County Wildlife and Conservation Association, although only 4 percent of the questionnaires were returned. Finally, a large number of specimens and information were obtained from interested local citizens who were aware of our study.

The year 1968 was the driest year for Mobile since 1954, and only a December rainfall of 10.70 inches kept it from being the driest year since 1938. A total of only 43.96 inches of rain was recorded in Mobile during 1968. The extremely dry conditions during the year when most of the trapping took place undoubtedly affected trap success.

Locality, date and habitat were recorded for each mammal taken during the investigation. Standard weights and measurements were recorded. The majority of the specimens were either made into study skins or preserved. Skulls were cleaned and carcasses preserved for future study. Males in breeding condition and females with embryos or placental

scars were noted. In the case of pregnant females, embryo crown-rump measurements were also recorded.

In the following species accounts, locality records for each species in a given county are divided into two groups. The localities listed first are those from which specimens have either been recorded in the literature, deposited in a mammal collection and verified by the author, or observed by either the author, Mr. Meyer, or another well-qualified, competent observer. All other locality data are preceded by the statement "this species reportedly occurs at \_\_\_\_\_". These latter localities were provided by sportsmen, farmers, and other citizens of the area, but they have not been verified by the author.

Unless otherwise stated, all measurements are given in mm and all weights are in grams.

Mammal collections at the following institutions were examined during this study: American Museum of Natural History, Athens (Ala.) College, Auburn University, Birmingham-Southern College, Carnegie Museum, Chicago Academy of Science, Chicago Field Museum of Natural History, Dayton (Ohio) Museum of Natural History, Delta State College, Florida State University, Jacksonville (Ala.) State University, Michigan State University, Millsaps College, Mississippi State University, Mississippi State Wildlife Museum, Purdue University, Samford University, Tulane University, University of Alabama, University of Florida, University of Georgia, University of Kansas, University of Michigan, University of Minnesota, University of South Alabama, University of Southern Mississippi and the United States National Museum.

The following abbreviations have been used to designate institutions or individuals possessing specimens: AMNH - American Museum of Natural History, New York, New York; AU - Auburn University, Auburn, Alabama; BSC - Birmingham-Southern College, Birmingham, Alabama; CAS - Chicago Academy of Science, Chicago, Illinois; DSC - Delta State College, Cleveland, Mississippi; HBS - Private collection of Dr. Harley B. Sherman, DeLand, Florida; JLW - Private collection of Dr. James L. Wolfe, Mississippi State University, Jackson; SU - Samford University, Birmingham, Alabama; UA - University of Alabama, Tuscaloosa; UF - University of Florida, Gainesville; UK - University of Kansas, Lawrence; UM - University of Michigan, Ann Arbor; USA - University of South Alabama, Mobile; USNM - United States National Museum, Washington, D. C.; WB - Private collection of Dr. W. W. Bowen, Destin, Florida.

#### SPECIES ACCOUNTS

##### Order MARSUPIALIA

##### Family DIDELPHIIDAE

##### *Didelphis marsupialis pigra* Bangs

##### Florida Opossum

*Distribution.* The opossum is one of the most common and generally distributed mammals in Alabama and has been recorded throughout all parts

## Mammals of Mobile and Baldwin Counties

of Mobile and Baldwin Counties. *Mobile Co.*: Alabama Port, Axis, Bucks, Citronelle, Coden, Delchamps, Georgetown, Grand Bay, Mobile, Mount Vernon, Semmes, Tanner-Williams, Theodore, and Wilmer. This species reportedly occurs at Creola and Turnerville. *Baldwin Co.*: Barnwell, Bay Minette, Belforest, Blacksher, Bon Secour, Bromley, Daphne, Elberta, Elsanor, Fairhope, Foley, Gulf Shores, Hurricane, Latham, Lottie, Loxley, Magnolia Springs, Malbis, Montrose, Orange Beach, Point Clear, Roberts-dale, Rosinton, Spanish Fort, Stockton, Summerdale, Tensaw. This species reportedly occurs at Perdido.

*Reproduction.* A female opossum with six nursing young was recorded from Mobile on March 23. A male in breeding condition was recorded from Mobile on February 24.

*Pelage.* Albino opossums have been taken in the Spring Hill and Cottage Hill sections of Mobile.

*Measurements.* 3 males: total length, 784 (698-870); tail, 295 (273-307); hind foot, 70 (63-75); weight (2), 6.4 lb (4.8-8.0 lb). 2 females: total length, 753 (745-760); tail, 315.5 (301-330); hind foot, 65 (65-65); weight 4.38 lb (4.25-4.5 lb). Sex undetermined (1): total length, 850; tail, 360; hind foot, 65.

*Location of Specimens.* USA, USNM, UA, UM, AMNH.

### Order INSECTIVORA

#### Family SORICIDAE

#### *Blarina brevicauda carolinensis* (Bachman)

#### Carolina Short-tailed Shrew

*Distribution.* Howell (15) reported that this shrew occurred in all sections of Alabama, but was less abundant in the southern part of the state. He recorded single specimens from Alabama Port and Spring Hill. Holliman (14) overlooked these specimens but did record this species from Baldwin County. Twenty-seven individuals were recorded during the present study. The majority were taken from moist woodland bordering swamps or streams. *Mobile Co.*: Alabama Port, Citronelle, Delchamps, Mobile. *Baldwin Co.*: Blacksher, Hurricane, Latham, Spanish Fort.

*Reproduction.* A female taken on November 11 contained four embryos (3R, 1L). A nursing individual was recorded on December 20.

*Measurements.* 7 males: total length, 95.0 (90-101); tail, 18.9 (16-21); hind foot, 12.2 (10.5-13.0); weight, 8.8 (7.0-10.5). 18 females: total length (17), 94.2 (85-102); tail, 19.8 (16-23); hind foot, 11.6 (10.5-13.0); weight (16), 7.9 (6.0-10.1). Sex undetermined (1): total length, 98; tail, 17; hind foot, 11.5.

*Location of Specimens.* USA, USNM.

*Cryptotis parva parva* (Say)

Least Shrew

*Distribution.* The least shrew is the smallest shrew occurring in southwestern Alabama. Howell (15) reported that although few specimens had been taken, it apparently was distributed generally over most of the state. He recorded three specimens from Mobile (one taken by Dr. Charles Mohr in 1890 and two captured by H. P. Loding around manure piles) and one individual from Alabama Port.

Thirteen *Cryptotis* were taken during the present investigation. These shrews, unlike *Blarina*, inhabit dry, grassy fields. They were most successfully captured by baiting wooden mouse traps with potted meat and setting the traps either in cotton rat runways or between clumps of vegetation. *Mobile Co.*: Alabama Port, Dawes, Grand Bay, Mobile. *Baldwin Co.* (FIRST COUNTY RECORD): Bon Secour, Foley, Hurricane, Lillian, Marlow, Robertsedale.

*Measurements.* 5 males: total length, 84 (81-90); tail, 20.9 (18-23); hind foot, 10.2 (9.5-11); weight (4), 4.3 (3.4-5.2). 3 females: total length (2), 80.5 (79-82); tail, 20 (19-22); hind foot, 10.3 (10-10.5); weight (2), 4.2 (4.1-4.3).

*Location of Specimens.* USA USNM, AU.

Family TALPIDAE

*Scalopus aquaticus howelli* Jackson

Howell Mole

*Distribution.* Evidence of the presence of moles at Mobile, Bayou La Batre and Orange Beach was noted by Howell (15), but no specimens had been recorded prior to the present study. These animals have been found in a large variety of habitats. Their presence in an area can be determined by the appearance of their characteristic tunnels usually located just beneath the surface of the ground and resulting in raised ridges. *Mobile Co.* (FIRST COUNTY RECORD): Citronelle, Dauphin Island, Delchamps, Mobile, Saraland. Tunnels have been observed at the following localities: Dawes and Dixon Corner. *Baldwin Co.* (FIRST COUNTY RECORD): Gulf Shores, Seminole. Tunnels have been observed at the following localities: Barnwell, Latham, Magnolia Springs, and Spanish Fort.

*Pelage.* An albino individual was taken in Mobile.

*Measurements.* 10 males: total length, 132.5 (117-164); tail, 20.5 (15-30); hind foot, 18.3 (17-20); weight (8), 50.8 (35.1-75.4). 3 females: total length, 144 (135-150); tail, 22.7 (20-26); hind foot, 19 (18-20); weight, 40.7 (32.9-51.0).

*Location of Specimens.* USA, AU.



## Mammals of Mobile and Baldwin Counties

### *Condylura cristata cristata* (Linnaeus)

#### Star-nosed Mole

Although this species has never been taken in Alabama, it is included here on the basis of several reliable reports near Stockton, Daphne, Fairhope and Foley in Baldwin County and in Mobile in Mobile County. A former schoolteacher in Foley and Fairhope reported that in the late 1940's and early 1950's, her students brought in several of these moles. A family living in Daphne reportedly observed a star-nosed mole pushing dirt from its tunnel in 1967. Approximately 15 years ago, one of these moles was reportedly captured in a worm bed near Dog River in Mobile and kept for several days before it escaped. During the current investigation, mole traps were set at these localities, but no specimens were obtained. Although Hall and Kelson (9) reported the nearest star-nosed moles as having been taken in the Okefinokee Swamp, it was felt that this species may occur in Mobile and Baldwin Counties and future trapping may definitely record its presence.

#### Order CHIROPTERA

#### Family VESPERTILIONIDAE

### *Myotis austroriparius austroriparius* (Rhoads)

#### Southeastern Myotis

*Distribution.* Although Hall and Kelson (9) showed the range of this bat as extending over the southern three-fourths of Alabama, it had only been taken in the state on two occasions (Jefferson Co., 1963; Conecuh Co., 1966) prior to the present investigation. On July 31, 1968, 6 specimens were removed from a narrow space atop a boat house extending into Mobile Bay at Fairhope, Alabama. Approximately 10 additional specimens were left undisturbed. *Baldwin Co.* (FIRST COUNTY RECORD): Fairhope.

*Measurements.* 6 males: total length, 86 (83-90); tail, 37.2 (35-40); hind foot, 9.4 (9.0-10.0); weight, 6.2 (5.8-6.75).

*Location of Specimens.* USA.

### *Eptesicus fuscus fuscus* (Beauvois)

#### Big Brown Bat

*Distribution.* The big brown bat was first recorded in southwestern Alabama in 1953 when five specimens were collected from the Biology Building on the Spring Hill College Campus in Mobile. The only specimen ever reported from Baldwin County was taken during the present study from the vicinity of Barnwell in the southeastern part of the county. *Mobile Co.:* Mobile. *Baldwin Co.* (FIRST COUNTY RECORD): Barnwell.

*Parasites.* White (31) recorded the mites *Neomyobia caudata* and *Pteracarus chalinolobus* from a bat taken in Mobile County.



*Measurements.* 2 males: total length, 109.5 (106-113); tail, 43. (41-46); hind foot, 9.5 (9-10); ear (1), 18.5; forearm (1), 44; weight, 12.4 (12.3-12.5). 4 females: total length, 108.8 (100-115); tail, 44.3 (38-51); hind foot, 9.8 (9-10); ear 18.4 (17.5-19); forearm, 45 (44-46); weight, 16.9 (13.5-18.6).

*Location of Specimens.* USA, UA.

*Lasiurus borealis borealis* (Müller)

#### Red Bat

*Distribution.* This bat was recorded from Point Clear in 1892 by Howell (15). This was the only record from Baldwin County until the present investigation when a nursing female and single young were recorded from Fairhope after falling from a tree. An uncataloged red bat from Gulf Shores was discovered in the mammal collection of Auburn University. Holliman (14) recorded the presence of this species in Mobile County on the basis of a single specimen that was captured and released. Thus, there was no substantiated record of this species in Mobile County until July, 1969, when a red bat was taken on the University of South Alabama campus in Mobile. *Mobile Co.* (FIRST COUNTY RECORD): Mobile. *Baldwin Co.*: Fairhope, Point Clear.

*Reproduction.* A nursing female carrying a single young individual (61-21.5-9-4.3) was recorded from Fairhope in Baldwin County on June 21 1968.

*Measurements.* 1 female: total length, 100; tail, 48; hind foot, 9; weight, 9.0.

*Location of Specimens.* USA, AU.

*Lasiurus seminolus* (Rhoads)

#### Seminole Bat

*Distribution.* Howell (15) recorded this bat from both Mobile and Baldwin Counties, although this data was apparently overlooked by Holliman (14). No specimens were taken during the present study. *Mobile Co.*: Dauphin Island, Mobile. *Baldwin Co.*: Orange Beach, Point Clear.

*Measurements.* 4 males: total length, 97.8 (94-102); tail, 41.0 (39-44); hind foot, 8.3 (7-9). 1 female: total length, 98; tail, 46; hind foot, 8.

*Location of Specimens.* USNM, AU.

*Lasiurus cinereus cinereus* (Palisot de Beauvois)

#### Hoary Bat

*Distribution.* The hoary bat has been recorded from only three counties in Alabama, two of which are Mobile and Baldwin Counties.

## Mammals of Mobile and Baldwin Counties

Howell (15) recorded one specimen taken at Point Clear on April 19, 1892. Holliman (14) recorded this species from Mobile County on the basis of a single specimen that was subsequently released. During the current investigation, two hoary bats were taken at Bellingrath Gardens near Delchamps on January 24, 1968, and January 5, 1969. Both were found alive on the ground. *Mobile Co.* (FIRST COUNTY RECORD): Delchamps, Mobile (?). *Baldwin Co.*: Point Clear.

*Measurements.* 2 females: total length, 100.5 (98-103); tail (1), 42; hind foot, 11.0 (9.5-12.5); weight, 12.9 (11.6-14.2).

*Location of Specimens.* USA, USNM.

*Lasiurus intermedius floridanus* (H. Allen)

### Yellow Bat

*Distribution.* Although Hall and Kelson (9) depicted the range of this species as extending across southern Alabama, no specimens had been recorded from the state until 1969. On March 24, 1969, a male yellow bat was captured after being knocked from a tree in Chickasaw, Mobile County (16). This specimen represents the first state record for this species. *Mobile Co.* (FIRST STATE RECORD): Chickasaw.

*Measurements.* 1 male: total length, 137; tail, 53; hind foot, 10; weight, 13.6.

*Location of Specimen.* USA.

*Nycticeius humeralis humeralis* (Rafinesque)

### Evening Bat

*Distribution.* The evening bat was first recorded from Mobile County in 1965 when several adults and young were taken from beneath a bridge over Fowl River south of Mobile. Howell (15) recorded four individuals from Baldwin County. During the present study, large colonies of this species were observed in the vicinity of Point Clear. Many of the large old homes in that area harbor colonies of evening bats, particularly in the attics and in the roofs. *Mobile Co.* (FIRST COUNTY RECORD): Faustinas. *Baldwin Co.*: Bon Secour, Fairhope, Foley, Point Clear.

*Parasites.* White (31) recorded the following mites from individuals of this species taken from Mobile and Baldwin Counties: *Ichoronyssus robustipes*, *Steatonyssus ceratognathus* and *Neomyobia caudata*.

*Measurements.* 13 males: total length, 84.5 (80-91); tail, 32.4 (30-35); hind foot, 8.2 (7.5-9.0); weight (11), 6.9 (6.1-7.5). 49 females: total length, 89.0 (80-103); tail, 35.3 (30-43); hind foot, 8.1 (6.5-9.5); ear (8), 13.3 (13-14); forearm (8), 34.0 (33-35); weight (47), 8.1 (6.0-10.6).

*Location of Specimens.* USA, USNM, UA, DSC.

*Tadarida brasiliensis cynocephala* (LeConte)

Brazilian Free-tailed Bat

*Distribution.* Although this species was not taken during the present study, it has been recorded from southwestern Alabama. Two specimens were shot at Orange Beach on January 24 and 28, 1912 (15). One bat was taken from the Foley High School Building in Foley on August 31, 1953, while four individuals were taken from the rafters of a fishing shelter on Foster's Pier at Fairhope on September 1, 1953. The only specimen of this bat from Mobile County was taken in the Biology Building of Spring Hill College in Mobile. *Mobile Co.*: Mobile. *Baldwin Co.*: Fairhope, Foley, Orange Beach.

*Parasites.* White (31) recorded the following mites from individuals of this species taken from Mobile and Baldwin Counties: *Ichoronyssus robustipes*, *Neomyobia inaequalis*, *Acanthophthirius longa*, *Teinocoptes tadarida* and *Olabidocarpus caylari*.

*Measurements.* 6 males: total length, 91.8 (85-95); tail, 33.0 (31-35); hind foot, 8.8 (8-9); ear (5), 18.9 (18.5-19); forearm (5), 39.6 (39-41); weight (4), 9.0 (8.4-9.7). 4 females: total length, 91.8 (89-94); tail, 32.5 (31-33); hind foot, 8.8 (8-10); ear (3), 18 (18-18); forearm (3), 39.7 (39-40); weight (1), 8.8.

*Location of Specimens.* USNM, UA, DSC.

Order EDENTATA

Family DASYPODIDAE

*Dasypus novemcinctus mexicanus* Peters

Nine-banded Armadillo

*Distribution.* The armadillo was not recorded in Alabama by Howell (15). However, geographic range of this animal has extended northward and eastward in the United States since about 1880. Taber (28) recorded the first armadillo from Alabama - a specimen taken within the city limits of Auburn but thought to have been an escaped pet. Fitch, Goodrum and Newman (7) recorded existence of the first established colony in the state at Foley in 1949. This colony was thought to have originated from a gravid female released in the area in 1937. McWilliams (20) was given three explanations for the presence of armadillos in Baldwin County by persons living in Orange Beach and Gulf Park:

- (1) "In those Texas ports armadillos slipped aboard tugboats like rats. The boatman finally discovered them and kicked them off here at the canal bridge....."
- (2) "Remember that camp for transients at Fort Morgan in the early '30's. Some of those men came from Texas. They had pet armadillos and turned 'em loose around the fort....."

## Mammals of Mobile and Baldwin Counties

- (3) "Never saw an armadillo - nobody ever saw one around here-till Roosevelt put up that CCC camp near Gulf Shores. Those CCC boys came from Texas. They are the ones who brought the armadillos in here. I give Roosevelt the credit....."

Since the climatic and soil conditions are favorable for armadillos, they have greatly increased in numbers; presently, they are quite common in all parts of Mobile and Baldwin Counties. Due to their burrowing habits, they are becoming classified as pests by many farmers and gardeners in this part of the state. However, the armadillo feeds upon many types of insects and invertebrates, and its burrows serve to aerate soil and provide refuges for many small animals. *Mobile Co.*: Alabama Port, Chunchula, Citronelle, Dawes, Delchamps, Faustinas, Georgetown, Grand Bay, Kushla, Laurendine, Mobile, St. Elmo, Tanner-Williams. This species reportedly occurs at Axis, Bucks, Creola, Turnerville, and Whistler. *Baldwin Co.*: Barnwell, Bay Minette, Bon Secour, Daphne, Elberta, Elsanor, Foley, Fort Morgan, Gateswood, Gulf Shores, Latham, Little River, Miflin, Montrose, Point Clear, Robertsedale, Rosinton, Spanish Fort, Stapleton, Stockton. This species reportedly occurs at Tensaw.

*Measurements.* 2 males: total length, 702 (654-750); tail, 330 (320-340); hind foot, 92.5 (92-93); weight, 7.5 lb (6.1-9.0 lb).

*Location of Specimens.* USA, BSC.

### Order LAGOMORPHA

### Family LEPORIDAE

### *Sylvilagus palustris palustris* (Bachman)

#### Marsh Rabbit

*Distribution.* Most hunters in Alabama do not distinguish between the swamp rabbit (*Sylvilagus aquaticus aquaticus*) and the marsh rabbit (*Sylvilagus palustris palustris*). Both forms are referred to as "swamp rabbits", thus making it extremely difficult to obtain accurate data from most hunters. Marsh rabbits are quite abundant in the salt marshes of Perdido Bay and Bon Secour River. In localities back from the coast, they live in the small wet, timbered swamps which are found at intervals along the streams and around ponds in the timber (15). The two specimens secured during the present study came from this type of area near Silverhill. This species has never been recorded west of Mobile Bay, in Mobile County. *Baldwin Co.*: Bon Secour, Loxley, Magnolia Springs, Orange Beach, Perdido Bay, Silverhill.

*Reproduction.* A female taken on February 8, 1969, contained 2 embryos (1R, 1L; CR=21 mm). A male taken on the same day was in breeding condition.

*Measurements.* 3 males: total length, 423.3 (400-445); tail, 35.3 (33-39); hind foot, 94.3 (91-98). 4 females: total length, 402.0 (400-456); tail, 33.3 (31-36); hind foot, 94.0 (87-98). Sex undetermined

(2): total length, 430 (400-460); tail, 43.5 (41-46); hind foot, 93.5 (90-97).

*Location of Specimens:* USA, USNM, AU.

*Sylvilagus floridanus alacer* (Bangs)

*Sylvilagus floridanus mallurus* (Thomas)

Eastern Cottontail

*Distribution.* *Sylvilagus floridanus mallurus* is the subspecies originally inhabiting the southeastern United States. However, as land was cleared and used for agricultural purposes, suitable habitat was created for the western subspecies, *Sylvilagus floridanus alacer*. Subsequently, it has been extending its geographical range eastward. Nelson (22), in his revision of the rabbits of North America, referred most of the Alabama cottontails to the subspecies *alacer*. Howell (15) indicated that they should be classified as *mallurus*. Hall and Kelson (9) referred all specimens from Mobile and Baldwin Counties to the subspecies *mallurus* although they depicted the ranges of these two subspecies as meeting along the Mississippi-Alabama state line. Holliman (13) recorded both subspecies as occurring in Mobile County. In Baldwin County he recorded *Sylvilagus floridanus mallurus* and specimens which he classified as intermediate between the two subspecies. Due to the uncertain taxonomic status of the eastern cottontail in this area, no subspecific identifications have been attempted during the current study. *Mobile Co.:* Alabama Port, Chickasaw, Chunchula, Citronelle, Dauphin Island, Dawes, Delchamps, Dixon Corner, Faustinas, Georgetown, Kushla, Mobile, Tanner-Williams, Whistler, Wilmer. This species reportedly occurs at Bayou La Batre, Creola, Grand Bay and Turnerville. *Baldwin Co.:* Barnwell, Bay Minette, Belforest, Bon Secour, Bromley, Elberta, Elsanor, Fairhope, Foley, Gateswood, Loxley, Malbis, Marlow, Montrose, Orange Beach, Perdido Bay, Point Clear, Robertsedale, Rosinton, Silverhill, Spanish Fort, Stapleton, Stockton, Summerdale. This species reportedly occurs at Fort Morgan.

*Reproduction.* A female taken on May 1, 1959, from Dauphin Island and currently in the University of Alabama Mammal Collection was pregnant and contained three embryos (CR=67, 77, 79 mm). A male taken on Feb. 1, 1969, from Mobile was in breeding condition.

*Pelage.* An albino cottontail was reported from near Alabama Port.

*Parasites.* A female *Sylvilagus floridanus mallurus* taken on Dauphin Island by Holliman (13) harbored a tick (*Haemaphysalis leporis-palustris*) and fleas (*Cediopsylla simplex* and *Odontopsylla multispinosus*).

*Measurements.* 9 males: total length, 434.7 (370-532); tail 45.2 (25-70); hind foot 95.3 (87-102); weight (2) 3.1 lb (2.7-3.5 lb). 6 females: total length, 414.8 (355-450); tail, 48.8 (34-59); hind foot 93.7 (85-97); weight (1), 2.25 lb.

*Location of Specimens.* USA, USNM, UA, UM.

## Mammals of Mobile and Baldwin Counties

### *Sylvilagus aquaticus aquaticus* (Bachman)

#### *Sylvilagus aquaticus littoralis* Nelson

#### Swamp Rabbit

*Distribution*: The swamp rabbit, or "cane-cutter" as it is locally known, is abundant and generally distributed over Alabama except in the extreme southern counties east of Mobile Bay, a region that is occupied by the marsh rabbit (*Sylvilagus palustris*). The subspecies *aquaticus* extends southward as far as Whistler in Mobile County and Stockton in Baldwin County. The coast race of the swamp rabbit, *littoralis*, is confined to a narrow belt along the Gulf coast. It ranges only a short distance from the coast marshes and is practically limited to the tide-water region. Howell (15) noted that specimens from the Tensaw River, four miles north of Hurricane, were intermediate between *littoralis* and *aquaticus*, but were best referred to the former. *Sylvilagus a. aquaticus* -- Mobile Co.: Chickasaw, Citronelle, Saraland, Satsuma, Whistler. Baldwin Co.: Stockton. *Sylvilagus aquaticus littoralis* -- Mobile Co.: Bayou La Batre, Blakeley Island, Mobile, Tanner-Williams. This subspecies reportedly occurs at Theodore. Baldwin Co.: Gravine Island, Hurricane, Mobile Causeway, Spanish Fort.

*Pelage*. Molting individuals were recorded on October 21 (2).

*Measurements*. *Sylvilagus a. aquaticus* - 2 males: total length, 440.0 (415-465); tail, 53.5 (45-62); hind foot, 102.0 (100-104); weight (1) 3.6 lb. 2 females. total length 474.0, (468-490); tail 53.0, (50-56); hind foot 99.0, (98-100); weight (1) 4.1 lb. *Sylvilagus aquaticus littoralis* - 4 males: total length 511.2, (480-545); tail 57.3, (46-68); hind foot 104.3, (99-109). 6 females: total length 525.8, (505-552); tail 61.7, (50-70); hind foot 105.3, (100-110).

*Location of Specimens*. USA, USNM.

#### Order RODENTIA

#### Family SCIURIDAE

#### *Sciurus carolinensis carolinensis* Gmelin

#### Gray Squirrel

*Distribution*. The gray squirrel is one of the most abundant and generally distributed mammals in southwestern Alabama. Hall and Kelson (9) indicated that this subspecies occurred throughout Baldwin County, while Mobile County was inhabited by the bayou gray squirrel, *Sciurus carolinensis fuliginosus*. Their range map was based on specimens obtained by Howell (15). Sanford (26) concluded that all gray squirrels in Alabama belonged to the same subspecies (*carolinensis*) except those in the southwestern part of the state, which were intergrades between *carolinensis* and *fuliginosus*. Mobile Co.: Axis, Bayou La Batre, Citronelle, Coden, Creola, Delchamps, Dixon Corner, Grand Bay, Little Bayou Canot, Mobile, Mt. Vernon, Saraland. This subspecies reportedly



occurs at Bucks, Chickasaw, Georgetown, Kushla, Semmes, Tanner-Williams, Theodore, Turnerville, and Wilmer. *Baldwin Co.*: Barnwell, Bay Minette, Belforest, Blacksher, Bon Secour, Bromley, Daphne, Elberta, Fairhope, Foley, Gulf Shores, Hurricane, Latham, Montrose, Orange Beach, Perdido, Perdido Bay, Point Clear, Robertsedale, Silverhill, Spanish Fort, Stockton. This subspecies reportedly occurs at Fort Morgan, Little River and Rosinton.

*Reproduction.* A four year study of this species in Alabama (4) revealed a breeding season extending from December to about August with peak activity in February and June. Average litter size was three young.

*Pelage.* Molting individuals were recorded on May 26 (1) and June 6 (1). Albino gray squirrels were observed on a number of occasions in Mobile. Albino individuals were observed near Mt. Vernon and Point Clear. A small population of gray squirrels with distinct yellowish pelage inhabits Bellingrath Gardens near Delchamps.

*Parasites.* Cole and Koepke (3) recorded fleas (*Orchopeas wickhami*) from gray squirrels in Mobile. Colin (4), in a study of this species in Alabama, recorded fleas, tail mites, chiggers, ticks and warbles.

*Measurements.* 44 males: total length, 437.4 (380-511); tail, 196.3 (140-235); hind foot, 61.1 (48-68.5); ear (4), 18.0 (17-19); weight (3), 311.7 (254-367). 28 females: total length, 436.7 (360-495); tail, 202.0 (173-235); hind foot, 62.0 (58-67); weight (2), 373.8 (352-395.5). Sex undetermined (2): total length, 416.0 (405-427); tail, 206.0 (185-227); hind foot, 60 (60-60); weight, 363.5 (355-372).

*Location of specimens.* USA, USNM, UA, AU, UM.

*Sciurus carolinensis fuliginosus* Bachman

Bayou Gray Squirrel

*Distribution.* The bayou gray squirrel was first reported in Alabama by Howell (15) who recorded this species from three localities in 1911, 1914, and 1917. At one of these localities (Stiggins Lake), Howell obtained three specimens, one of which was typical of *fuliginosus*, the others intermediate between this subspecies and *carolinensis*. He noted that this squirrel was confined to the shores of bayous and the deep cypress swamps. Lowery (17) reported *fuliginosus* as being found deep in the swamps of Mobile and Baldwin Counties. Holliman (14) stated that this subspecies was found mainly in Mobile, Baldwin and Washington Counties, extending northward along the river bottoms of the Mobile, Tombigbee and Alabama rivers. *Mobile Co.*: Bayou La Batre, Mobile. *Baldwin Co.*: Chuckvee Bay, Stiggins Lake (3 miles east of Mt. Vernon).

*Measurements.* 1 male: total length, 440; tail, 212; hind foot, 60.

*Location of Specimens.* USNM.

*Sciurus niger bachmani* Lowery and Davis

Bachman Fox Squirrel

*Distribution.* The fox squirrel is an uncommon inhabitant of large, dry tracts of mostly large oak and pine forests throughout Mobile and Baldwin Counties. Unlike the gray squirrel, it is never found in low, wet bottomland. *Mobile Co.* (FIRST COUNTY RECORD): Mobile, Saraland, Theodore, Wilmer. This species reportedly occurs at Axis, Bayou La Batre, Bucks, Citronelle, Creola, Delchamps, Georgetown, Grand Bay, Pennsylvania, Prichard, Semmes, Tanner-Williams and Turnerville. *Baldwin Co.:* Bay Minette, Belforest, Latham, Magnolia Springs, Malbis, Orange Beach, Weeks Bay. This species reportedly occurs at Elberta, Fairhope, Foley, Hurricane, Lillian, Little River, Montrose, Perdido, Silverhill, Stockton and Tensaw.

*Pelage.* The fox squirrel has three basic color phases - red, gray and black. Several persons have reported the occurrence of the red phase in this area. Black fox squirrels have been reported near Stockton, Foley and Tensaw. A molting squirrel was recorded on May 21.

*Measurements.* 2 males: total length, 577.5 (570-585); tail, 267 (258-276); hind foot, 83 (79-87); weight (1), 2 lb. 3 females: total length, 581 (565-597); tail, 287.3 (262-306); hind foot, 77.3 (75-79); weight (1), 574.

*Location of Specimens.* USA, USNM, UA, SU.

*Glaucomys volans saturatus* A. H. Howell

Southern Flying Squirrel

*Distribution.* The flying squirrel is generally distributed throughout this area. Since it is a nocturnal animal, its presence in an area is often unsuspected by persons living nearby. They usually inhabit hollow trees or stumps, but they are frequently found in attics or other buildings. *Mobile Co.:* Citronelle, Delchamps, Mobile, Semmes. This species reportedly occurs at Axis, Chickasaw, Creola, Dawes, Grand Bay, Pennsylvania, Tanner-Williams, Theodore, Turnerville and Whistler. *Baldwin Co.:* Belforest, Foley, Montrose, Perdido River, Spanish Fort. This species reportedly occurs at Bay Minette, Elberta, Gulf Shores, Latham, Little River, Malbis, Perdido, Point Clear, Stockton and Summerdale.

*Reproduction.* Three young flying squirrels, less than one week old, were found near the base of a tree on the University of South Alabama campus on December 12, 1967. An adult female and three young between four and five weeks of age were taken on January 13, 1969. Juvenile squirrels have also been recorded on December 10 and January 9 from Mobile County.

*Measurements.* 3 males: total length, 229.7 (218-250); tail, 102.7 (98-110); hind foot (2), 31.5 (31-32). 4 females: total length, 226.0

(201-245); tail, 99.8 (92-112); hind foot, 32.5 (31-33); weight (1), 38.2.

*Location of Specimens.* USA, USNM, UA.

Family GEOMYIDAE

*Geomys pinetis mobilensis* Merriam

Southeastern Pocket Gopher

*Distribution.* The pocket gopher inhabits south-central and south-eastern Alabama, including Baldwin County. No specimens have ever been recorded from Mobile County. During the current study, only one pocket gopher was collected. It was taken in a burrow located in the sandy bank of a drainage ditch which had been formed by a roadfill. The tunnel extended parallel to the drainage ditch as well as extending beneath the macadam road. This specimen was taken in a rat trap baited with peanut butter. *Baldwin Co.*: Daphne, Fairhope, Orange Beach, Point Clear. Gopher mounds were reportedly observed many years ago near Elberta.

*Measurements.* 4 males: total length, 247.8 (235-260); tail, 81.1 (75-88); hind foot, 33.5 (32-36). 16 females: total length, 229.3 (215-252); tail, 73.1 (60-82); hind foot, 31.2 (30-34); weight (4), 152.9 (121.4-180.0). Sex undetermined (3): total length, 233.3 (230-240); tail, 62.3 (58-65); hind foot, 28.0 (25-30).

*Location of Specimens.* USA, USNM, CAS, UK, UM, HBS.

Family CASTORIDAE

*Castor canadensis carolinensis* Rhoads

Beaver

*Distribution.* Although occupying practically the entire state of Alabama in early times, beaver were extirpated from the major portion of their range as the land was settled. Howell (15) noted the relative scarcity of these animals in Alabama except in Montgomery and Lowndes Counties. He noted that a few might remain near Bayou La Batre in Mobile County. He also related that in 1915 an experienced trapper noticed a few signs of beaver in Little River, on the northern boundary of Baldwin County. In 1938, the statewide population of beaver was estimated at not more than 500 animals (23). Beginning in June, 1940, beaver were transplanted over the state and now their numbers have greatly increased. By 1964, an estimated population of over 100,000 animals inhabited Alabama (23). Although only one beaver was taken during the present investigation, reports and observations indicated that this large rodent occurred in limited numbers throughout the greater part of both counties. *Mobile Co.* (FIRST COUNTY RECORD): Dawes, Satsuma. This species reportedly occurs at Bayou La Batre, Citronelle, Kushla, Mobile, Mt. Vernon, Pennsylvania, and Semmes. *Baldwin Co.*: Bay Minette, Belforest, Elberta, Latha, Robertsdale, Stockton. This species reportedly occurs at Barnwell, Bay Minette Creek, Montrose and Tensaw.

Mammals of Mobile and Baldwin Counties

*Longevity.* A beaver released on November 4, 1944, in Mobile County was recovered 7 1/4 years later during the trapping season of 1951-1952 (11). It was recaptured 17 miles from its point of release.

*Measurements.* 1 female: total length, 41 3/4"; tail, 13"; hind foot, 6 7/8"; weight, 36.5 lb.

*Location of Specimen.* USA.

Family CRICETIDAE

*Oryzomys palustris palustris* (Harlan)

Marsh Rice Rat

*Distribution.* The rice rat is an inhabitant of wet, marshy fields, wooded swamps and coastal salt marshes. In this study, specimens were secured from each of these types of habitats. This species was found in large numbers in the marshes on the west end of Dauphin Island. Howell (15) reported that this species was particularly abundant on Blakeley Island near Mobile and around Little Lagoon near Gulf Shores. No specimens have been recorded from the northern half of Baldwin County. *Mobile Co.:* Bayou La Batre, Citronelle, Dauphin Island, Faustinas, Georgetown, Kushla, Mobile. *Baldwin Co.:* Bon Secour, Chocaloque (Chacaloochee?) Bay near Mobile, Gulf Shores, Marlow.

*Reproduction.* A female taken on March 19 near Georgetown contained placental scars (3R, 1L). A female taken along the Fish River near Marlow on July 3 contained 4 embryos (2R, 2L; CR=20mm). A male in breeding condition was recorded near Citronelle on March 21. Six adult females taken on Dauphin Island in mid-December contained no embryos or placental scars while seven adult males from the same locality had very small testes and were not in breeding condition.

*Parasites.* Royal (25) recorded lice (*Hoplopleura oryzomydis*) on a male from Chocaloque (Chacaloochee?) Bay and fleas (*Polygenis gwyni*) from a male taken at Gulf Shores.

*Pelage.* Molting individuals have been recorded on March 19 (1) and December 17 (1).

*Measurements.* 21 males: total length, 252.5 (220-287); tail (20), 123.5 (110-144); hind foot (20), 30.5 (23-33); weight (8), 68.6 (55.2-88.5). 9 females: total length, 245.8 (226-264); tail, 117.1 (107-127); hind foot, 30.3 (30-32); weight (8), 54.8 (50.1-72.9). Sex undetermined (1): total length, 237; tail, 112; hind foot, 28.

*Location of Specimens.* USA, USNM, UA, JLW.

*Reithrodontomys humulis*

Eastern Harvest Mouse

No individuals of the genus *Reithrodontomys* were taken during this

investigation. However, a United States Department of Agriculture report issued in July, 1969, recorded this species from a study area near Grand Bay in Mobile County. However, subsequent trapping by the author on this study area during July, 1970, failed to secure any specimens.

*Peromyscus polionotus polionotus* (Wagner)

Oldfield Mouse

*Distribution.* A recent study by Bowen (2) revealed that Baldwin County was inhabited by three subspecies of the oldfield mouse (*Peromyscus polionotus polionotus*, *Peromyscus polionotus ammobates*, and *Peromyscus polionotus trissyllepsis*). The latter two subspecies are found only along the coast, while *polionotus* may be found throughout the southern two-thirds of Baldwin County (9) or throughout the entire county (2). Howell (15) reported finding these mice in overgrown sandy fields, corn fields and cotton fields, as well as in open timbered tracts throughout the eastern, central and northeastern parts of Alabama. Mobile Bay apparently forms a barrier to the westward distribution of this species, since no evidence of its presence has ever been found in Mobile County. Four specimens taken from five miles north of Gulf Shores represent the only individuals of this subspecies from Baldwin County. No specimens were taken during the current investigation. *Baldwin Co.*: 5 miles north of Gulf Shores.

*Measurements.* 2 males: total length, 116 (114-118); tail, 46.8 (44-49.5); hind foot, 17 (17-17). 1 female: total length, 123; tail, 54.5; hind foot, 17.5.

*Location of Specimens.* AU

*Peromyscus polionotus ammobates* Bowen

White-fronted Beach Mouse

*Distribution.* Bowen (2) determined the distribution of this form to be the coastal dunes between Mobile Bay and Perdido Bay, including Ono Island at the mouth of Perdido Bay. Six specimens taken by A. H. Howell in 1908 near Bon Secour and classified as *Peromyscus polionotus albifrons* were reexamined by Bowen (2) and found to be closer to the subspecies *ammobates*. During the current investigation, specimens were obtained along the coast of Baldwin County, but extensive trapping along the sand dunes of Dauphin Island in Mobile County yielded no specimens.

These mice, which represent a pale race of the oldfield mouse, are most numerous in the line of dunes nearest the surf. Ground cover in these areas is very sparse and consists mainly of live-oak bushes and patches of sea oats (*Uniola paniculata*). The mice live in burrows in the sand, with each burrow usually having a small, round entrance hole. *Baldwin Co.*: Alabama Point, Bon Secour (=dunes near Little Lagoon, according to notations on some labels), Fort Morgan, Gulf Shores, Ono Island, Orange Beach.

*Reproduction.* A female taken on April 7, 1952, contained five embryos (CR=13mm).

## Mammals of Mobile and Baldwin Counties

*Food.* Howell (15) noted that the stomach of one specimen contained remains of red berries, while that of another contained finely chewed vegetable matter, probably seeds.

*Parasites.* No insect ectoparasites were found on four specimens taken at Gulf Shores (25).

*Measurements.* 25 males: total length, 123.4 (114-139); tail, 51.1 (42.5-60); hind foot, 18.0 (17-19.5); ear (5), 14.8 (14-15); weight (2), 10.9 (9.1-12.7). 38 females: total length (37), 129.3 (112-145.5); tail (37), 53.4 (42-61); hind foot, 18.0 (17-20); ear (10), 14.8 (13-16); weight (1), 9.4.

*Location of Specimens.* USA, USNM, UF, UK, UM, WB, JLW.

### *Peromyscus polionotus trissyllepsis* Bowen

#### Floral Beach Mouse

*Distribution.* Bowen (2) gave the distribution of this form as the coastal dunes between Perdido Bay and Pensacola Bay, Alabama and Florida. In Alabama, it is known only from Florida Point, east of Perdido Inlet, in Baldwin County. It is a paler form than *ammobates*. *Baldwin Co.:* Florida Point.

*Measurements.* 3 males: total length, 127.2 (120-135.5); tail, 51.7 (49-54); hind foot, 18.0 (18-18); ear, 14.8 (14.5-15.0). 4 females: total length, 128.3 (118-137); tail, 50.5 (46-54); hind foot, 17.5 (17-18); ear, 14.9 (14.5-15.0). Sex undetermined (1): total length, 123; tail, 47; hind foot, 17; ear, 13.5.

*Location of Specimens.* UF, WB.

### *Peromyscus gossypinus gossypinus* (LeConte)

#### Cotton Mouse

*Distribution.* Although Howell (15) and Holliman (14) recorded this mouse only from Baldwin County, the present study has revealed that this mouse is abundantly distributed throughout both Mobile and Baldwin Counties. This species prefers timbered swampland as well as wooded hillsides and brushy areas near water. *Mobile Co.* (FIRST COUNTY RECORD): Bucks, Chunchula, Citronelle, Delchamps, Grand Bay, Kushla, Mobile, St. Elmo, Semmes, Theodore, Wilmer. *Baldwin Co.:* Barnwell, Bay Minette, Big Bay John, Blacksher, Bromley, Daphne, Elsanor, Gateswood, Gulf Shores, Hurricane, Lillian, Little River, Magnolia Springs, Orange Beach, Point Clear, Rabun, Robertsedale, Rosinton, Seminole, Spanish Fort, Stapleton, Stockton.

*Reproduction.* Females with embryos or placental scars have been taken on February 15 (1R, 2L); March 16 (plac. scars 3R, 3L); March 18 (3R, 1L); March 20 (2R, 2L; CR=17mm); May 2 (plac. scars 3R, 1L); July 2 (1R, 2L); September 12 (OR, 3L; CR=17mm), and December 13 (OR, 3L). An unusually small, reproductively mature female (118-39-17-10.1 g), taken



on July 2, contained 3 embryos (OR, 3L). Nursing females have been recorded on March 16, December 12 and December 20. Immature animals have been noted on January 2, February 15, March 17, March 21, May 16, December 12, December 18, and December 20. Males in breeding condition have been taken in February (2), March (6), June (2), August (2), September (2) and December (4). These data indicate that breeding occurs throughout the year in this area.

*Pelage.* Molting individuals have been recorded on February 15 (2), March 21 (1), April 26 (1), May 2 (2), June 11 (1), December 4 (1), December 5 (1), December 12 (2), December 13 (1) and December 18 (1).

*Measurements.* 68 males: total length (66), 166.0 (148-188); tail (67), 71.9 (60-100); hind foot, 22.3 (20-25); weight (55) 25.8 (14.5-38.0). 37 females: total length, 168.3 (150-191); tail, 71.2 (59-85); hind foot, 22.3 (20-24); weight (30), 25.1 (16.5-36.2). Sex undetermined (2): total length, 156 (155-157); tail, 62 (58-66); hind foot, 22 (21-23); weight, 25.1 (24.3-25.9).

*Location of Specimens.* USA, USNM, UA, AU.

*Ochrotomys nuttalli aureolus* (Audubon and Bachman)

#### Golden Mouse

*Distribution.* The golden mouse occurs in isolated populations throughout Mobile County and the southern portion of Baldwin County. However, extensive trapping in suitable habitat has failed to reveal its presence in the northern two-thirds of Baldwin County. This species is most often taken in swampy or moist woodland, generally in the vicinity of a stream or larger body of water. It is semi-arboreal and prefers areas of thick undergrowth, such as honeysuckle or greenbrier (*Smilax* sp. *Mobile Co.*: Bucks, Chunchula, Citronelle, Delchamps, Mobile, Semmes, Wilmer. *Baldwin Co.*: Barnwell, Marlow, Point Clear, Seminole.

*Reproduction.* Males in breeding condition have been taken in March (5), July (1), and September (1). A juvenile individual was recorded on May 9, 1968.

*Pelage.* Molting individuals have been recorded on March 20 (1) and June 25 (1).

*Measurements.* 14 males: total length, 170.1 (130-201); tail, 82.5 (73-92); hind foot, 19.4 (16-24.5); weight, 20.7 (15.3-29.1). 5 females: total length, 152.2 (145-166); tail, 69.4 (64-76); hind foot (4), 18.5 (16.5-20); weight, 15.1 (13.1-19.1).

*Location of Specimens.* USA, USNM.

*Sigmodon hispidus hispidus* Say and Ord

#### Hispid Cotton Rat

*Distribution.* The hispid cotton rat is the most abundant rodent in the fields and farm lands of southwestern Alabama and has been taken

## Mammals of Mobile and Baldwin Counties

throughout Mobile and Baldwin Counties. It is found in grassy fields, brushy pastures, marshes, and along the brushy or weed-grown borders of cultivated fields. Although Howell (15) noted this species from Mobile County, it was omitted by Holliman (14). *Mobile Co.*: Alabama Port, Bayou La Batre, Blakeley Island, Bucks, Chunchula, Citronelle, Coden, Dawes, Georgetown, Grand Bay, Kushla, Laurendine, Mobile, St. Elmo, Theodore. *Baldwin Co.*: Barnwell, Blacksher, Bon Secour, Elberta, Elsanor, Fairhope, Foley, Gulf Shores, Hurricane, Latham, Lillian, Lottie, Loxley, Magnolia Springs, Marlow, Miflin, Robertsedale, Seminole, Silverhill, Stapleton, Summerdale.

*Reproduction.* Females with embryos or placental scars have been taken on March 21 (plac. scars 2L, 3R); March 23 (plac. scars 2L, 1R); March 25 (plac. scars 2L, 2R); April 26 (1L, 1R); May 10 (2L, 4R; CR=40mm); May 10 (1L, 3R; CR=34mm); May 11 (2L, 1R; CR=16mm); May 16 (5L, 3R; CR=30mm); June 11 (3L, 3R; CR=30mm); June 25 (3L, 2R; CR=49mm); July 2 (1L, 1R; CR=11.5mm); July 9 (3L, 2R; CR=15mm); July 9 (plac. scars 3L, 1R); and November 19 (3L, OR). A female taken on May 10 had 4 embryos (CR=12mm) in the right uterine horn and 3 placental scars in the left uterine horn. Males in breeding condition have been recorded on February 15, February 19, March 16 (2), March 18, March 21, May 10 (2), May 11, May 16, May 23, June 11, July 2, November 19 (2), and November 20. Juvenile individuals have been taken on March 17, March 18, March 19, May 10 (2), May 17, May 24, November 19 and November 23. Since specimens were collected during every month of the year, these data indicate that the main breeding season in this area extends from approximately February to July and that from July through January breeding activity decreases considerably.

*Pelage.* Molting individuals have been recorded in November (24) and January (1).

*Parasites.* Royal (25) recorded fleas (*Polygenis gwyni*) and lice (*Hoplopleura hirsuta*) from a male *Sigmodon* taken at Gulf Shores.

*Measurements.* 72 males: total length, 245.6 (190-310); tail (71), 97.7 (67-124); hind foot (71), 32.5 (29-36.5); weight (63), 111.8 (54.1-225.7). 80 females: total length (78), 219.6 (184-288); tail (77), 92.6 (60-115); hind foot, 31.4 (25-34.5); weight (75), 97.6 (42.4-261.8).

*Location of Specimens.* USA, USNM, UA, AU, CAS, JLW.

*Neotoma floridana illinoensis* A. H. Howell

*Neotoma floridana rubida* Bangs

Eastern Wood Rat

*Distribution.* The distribution of these two subspecies in southwestern Alabama is unclear. Goldman (8) concluded from a series of eight specimens from Mobile, Mobile Bay and Mobile River that the wood rat occurring in this area was *Neotoma floridana rubida*. However, Howell (15) assigned all Alabama specimens taken south of the Tennessee River to the subspecies *floridana*. Zambenardi (33) also assigned the wood rats from Mobile and Baldwin Counties to the subspecies *floridana* on the basis of

measurements and coloration. A comprehensive analysis of the wood rats of the eastern United States by Schwartz and Odum (27) revealed that Goldman's specimens most closely resembled *rubida*. Hall and Kelson (9) supported this conclusion and depicted the range of *rubida* as including all of Mobile County and the western half of Baldwin County. During the current study, four adult specimens were trapped - two from Citronelle and two from Mobile. On the basis of pelage color, one specimen from each locality appeared to be *rubida*, while the other specimen seemed best referred to the subspecies *illinoensis*. A large series of wood rats is needed from this part of Alabama before the ranges of these subspecies can be determined. *Mobile Co.*: Chunchula, Citronelle, Mobile. *Baldwin Co.*: Hurricane, Orange Beach, Point Clear, Rabun, Spanish Fort.

*Pelage.* Molting individuals have been recorded on June 26 (1) and November 23 (1).

*Predation.* This species was recorded from the stomach of a bobcat (*Lynx rufus*) taken in Baldwin County (6).

*Parasites.* Cole and Koepke (3) recorded fleas (*Rhopalopsyllus gwyni*) and mites (*Atricholaelaps glasgowi*) from 68 wood rats taken in Mobile during 1934.

*Measurements.* 8 males: total length, 377.6 (350-428); tail, 166.2 (130-199); hind foot, 38.3 (35-41); weight (1), 280. 7 females: total length (6), 370.0 (323-403); tail (6), 170.5 (144-192); hind foot, 36.8 (35-39); weight (2), 208.2 (165.9-250.4).

*Location of Specimens.* USA, USNM.

*Microtus* sp.

"Field Mouse"

No individuals of the genus *Microtus* have ever been taken in Mobile or Baldwin Counties, with one possible exception. Cole and Koepke (3) recorded a "field mouse (*Microtus*)" from Mobile. If their identification was correct, it would seem most probable that their "field mouse" was a pine vole (*Microtus pinetorum*) whose range covers the northern three-quarters of the state. However, after our extensive trapping in all areas of the county and in all habitats, it seemed very unlikely that this species is a member of the fauna of this area.

*Ondatra zibethicus rivalicicus* (Bangs)

Louisiana Muskrat

*Distribution.* Howell (15) noted that this small, dark-colored muskrat was found in Alabama only in the coast region west of Mobile Bay and that its range had extended into the state within very recent times. He recorded specimens from only one locality - Bayou La Batre, but he noted that their signs were seen in Three Mile Creek in Mobile in 1913. Howell found this species was unknown to most hunters and trappers and

those who were acquainted with it stated that it first appeared shortly after a big storm in 1906. Howell stated that the muskrat would undoubtedly spread out and become more abundant along the western shore of Mobile Bay and he saw no reason why it should not extend into the marshes of the Delta region and along the eastern shore of Mobile Bay. The population gradually increased during the early 1930's until it reached a peak in 1936-37 when one buyer was reported to have purchased 65,000 pelts (19). This was followed by a disastrous decrease which resulted in closure of the trapping season in 1939. It remained closed until the 1945-46 season. Martin (19) speculated that disease was probably responsible for the sudden decline and near-disappearance of muskrats in this area.

Findings of the present study confirm Howell's theory concerning distribution of this species. Specimens were recorded from a number of areas in the eastern and southern portions of Mobile County, in the marshes of the Delta region and as far south as Montrose in Baldwin County. *Mobile Co.*: Alabama Port, Bayou La Batre, Mobile Bay Delta. This species reportedly occurs at Axis, Creola, Mobile and Turnerville. *Baldwin Co.*: Mobile Causeway, Montrose. This species reportedly occurs in Bay Minette Creek north of Spanish Fort, Little Bateau Bayou, and in Lower Crab Creek.

*Measurements.* 11 males: total length, 531.6 (475-599); tail (7), 239.3 (196-258); hind foot (8), 79.1 (74-83); ear (4), 21.3 (21-22); weight (1), 2½ lb. 10 females: total length, 516.3 (425-589); tail (4), 235.3 (228-244); hind foot (8), 79.4 (74-85); ear (3), 20.3 (19-22); weight (1), 2½ lb. Sex undetermined (1): total length, 543; tail, 232; hind foot, 71; weight, 2 lb.

*Location of Specimens.* USA, USNM, UF, UM.

#### Family MURIDAE

This family of rodents contains the Old World rats and mice which have been introduced into North America. Three species are found in southwestern Alabama closely associated with man's habitations and thus are found abundantly in cities, towns, farm buildings, dumps, etc. Since these are non-native mammals, no attempt was made to collect specimens or sample populations.

*Rattus rattus rattus* (Linnaeus)

*Rattus rattus alexandrinus* (E. Geoffroy Saint-Hilaire)

*Rattus rattus frugivorus* (Rafinesque)

#### Black Rat

*Distribution.* Three subspecies of the black rat reportedly occur in southwestern Alabama. Because of interbreeding between the three subspecies and because stocks from other continents have been introduced repeatedly, it is difficult, often impossible, to assign specimens to a definite subspecies. *Mobile Co.*: Alabama Port, Bayou La Batre, Dauphin Island, Mobile, Theodore. *Baldwin Co.*: Belforest, Little River, Mobile Causeway.

*Reproduction.* A female taken on January 2 contained seven very small embryos (3L, 4R), while a female taken on October 1 was nursing. Males taken on February 6 and December 17 were in breeding condition. Juvenile individuals have been taken on March 14, May 8, May 17, and November 23.

*Parasites.* Cole and Koepke (3) recorded the following ectoparasites from this species in Mobile: fleas (Siphonaptera) - *Xenopsylla cheopis*, *Echidnophaga gallinacea*, *Leptopsylla segnis*, *Nosopsyllus fasciatus*, *Ctenocephalides felis*; mites (Acarina) - *Laelaps hawaiiensis*, *Echinolaelaps echidninus*; lice (Anopleura) - *Polyplax spinulosa*, *Hoplopleura* spp.

*Measurements.* 3 males: total length, 379.3 (370-385); tail, 200.1 (195-207); hind foot, 35.5 (34.5-37); weight, 161.2 (140.2-201.0). 6 females: total length, 350.5 (323-402); tail, 193.3 (160-230); hind foot, 35.9 (34-37); weight, 125.0 (96.1-172.5).

*Location of Specimens.* USA, JLW.

*Rattus norvegicus norvegicus* (Berkenhout)

Norway Rat

*Distribution.* Although this species lives chiefly in towns and around farm buildings, it often ranges into fields for a considerable distance, particularly along ditch banks and borders of marshy bottoms (15). No specimens were taken during the current study. *Mobile Co.*: Dauphin Island, Mobile. Holliman (14) reported they were quite common in Alabama Port, Bayou La Batre, and Mobile. *Baldwin Co.*: Magnolia Springs.

*Parasites.* Cole and Koepke (3) recorded the following ectoparasites from this rat in Mobile: fleas (Siphonaptera) - *Xenopsylla cheopis*, *Nosopsyllus fasciatus*, *Leptopsylla segnis*, *Echidnophaga gallinacea*, *Ctenocephalides felis*, *Rhopalopsyllus gwyni*, *Pulex irritans*; mites (Acarina) - *Laelaps glasgowi*, *Echinolaelaps echidninus*, *Eulaelaps stabularis*, *Liponyssus bacoti*, *Atricholaelaps glasgowi*; lice (Anopleura) - *Polyplax spinulosa*, *Hoplopleura* spp.

*Measurements.* 2 males: total length, 355.0 (320-390); tail, 208.1 (197-220); hind foot, 36.0 (35-37).

*Location of Specimens.* UA, SU.

*Mus musculus brevisrostris* Waterhouse

House Mouse

*Distribution.* This species occurs throughout Mobile and Baldwin Counties. It is found abundantly in waste lands and cultivated fields as well as in the vicinity of buildings. All specimens recorded during the current study were taken in fields and not from buildings. *Mobile Co.*: Bayou La Batre, Dauphin Island, Grand Bay, Irvington, Laurendine, Mobile Tanner-Williams. *Baldwin Co.*: Belforest, Blacksher, Fairhope, Gulf Shores, Lillian, Little River, Magnolia Springs, Marlow, Point Clear.



## Mammals of Mobile and Baldwin Counties

*Reproduction.* Females containing placental scars have been taken on January 10 (4L, OR) and February 8 (2L, 4R). Males in breeding condition have been recorded on January 10, November 20, and December 18.

*Pelage.* Molting individuals have been recorded on May 24 (1), October 27 (1), November 19 (1), November 21 (1), November 22 (2) and December 19 (1).

*Measurements.* 33 males: total length (32), 150.7 (130-185); tail (32), 73.9 (63-100); hind foot (30), 17.8 (15-19); weight (29), 12.8 (8.8-20.4). 28 females: total length (26), 147.8 (131-169); tail (26), 72.2 (61-83); hind foot, 17.2 (15.5-19); weight (26), 12.2 (7.25-21.2).

*Location of Specimens.* USA, UA, SU, JLW.

### Family CAPROMYIDAE

*Myocastor coypus bonariensis* (E. Geoffroy St.-Hilaire)

#### Nutria

*Distribution.* The nutria is not native to the United States, having been imported from South America into Texas as a fur bearer in the 1930's. Since that time, it has spread to the Gulf Coast of Louisiana. Lueth (18) reported that four pairs of nutria were introduced into the Mobile Delta marshes on September 18, 1948, by the Alabama State Department of Conservation. Holliman (14) noted that nutria were introduced into Mobile Bay in May, 1949, and again in February, 1950. He stated that at least 18 animals were released to control cane, cutgrass, alligator weed and other noxious water weeds which threatened to choke out open water that could be utilized by diving ducks. Since that time, nutria have multiplied rapidly and are competing with the native muskrat (*Ondatra zibethicus*) and waterfowl for food by destroying tidal vegetation necessary to control wave action and subsequent erosion. This serves as a classic case of a species being introduced into an area before its life history and habits have been thoroughly studied and before all of the possible ramifications and effects upon the native wildlife have been examined. *Mobile Co.:* Alabama Port, Delchamps, Mobile, Mobile Delta (Bay Grass, Conway Creek, Little Bayou Canot, Lower Crab Creek, Raft River Peninsula, Slater Island and Tensaw River). *Baldwin Co.:* Daphne, Gulf Shores, Mobile Causeway, Spanish Fort.

*Reproduction.* A very young nutria and a female with nearly full-term embryos were taken in March near Mobile.

*Measurements.* 5 males: total length, 861 (675-960); tail, 353.8 (219-430); hind foot, 127.8 (115-141); weight (4), 9.6 lb (6.5-12.25 lb). 2 females: total length, 828.5 (717-940); tail, 338.0 (321-355); hind foot, 125.0 (117-133); weight, 7.3 lb (6.8-7.8 lb).

*Location of Specimens.* USA, UA.



Order CETACEA

Family DELPHINIDAE

*Tursiops truncatus* (Montague)

Atlantic Bottle-nosed Dolphin

*Distribution.* Dolphins occasionally are seen swimming in Mobile Bay and the Gulf of Mexico. It is not unusual to find a dead dolphin or a dolphin skull on the Gulf Coast beaches of Mobile and Baldwin Counties. *Mobile Co.* (FIRST COUNTY RECORD): Dauphin Island, Mobile. *Baldwin Co.*: This species reportedly occurs along the Fort Morgan peninsula.

*Location of Specimens.* USA, UA.

*Globicephala* sp. (prob. *macrorhyncha* Gray)

Black Pilot Whale

*Distribution.* Only one specimen of this marine mammal has come to the author's attention. In September, 1962, a black pilot whale, or short-finned blackfish as it is also known, washed up on the beach at Alabama Point, east of Gulf Shores, in Baldwin County. A photograph of the specimen appeared in the October, 1962, issue of the South Alabama Sportsman. *Baldwin Co.* (FIRST COUNTY RECORD): Alabama Point.

*Location of Specimens.* There are no known specimens in existence from Mobile or Baldwin Counties.

Order CARNIVORA

Family CANIDAE

*Canis latrans*

Coyote

Although there have been several unverified reports of coyotes being killed in Alabama, none of these had been in Mobile or Baldwin Counties. However, on February 23, 1970, an animal resembling a coyote was killed near the junction of the Middle and Tensaw Rivers in Mobile County. A determination by the U. S. National Museum revealed that the animal was most likely a coyote but that the skull had several definite wolf-like characteristics; this animal may have been a coyote-red wolf hybrid. *Mobile Co.* (FIRST COUNTY RECORD): Junction of Middle and Tensaw Rivers.

*Measurements.* 1 male: total length, 1263; tail, 350; hind foot, 204; weight, 29 lb.

*Location of Specimen.* USA.

## Mammals of Mobile and Baldwin Counties

### *Canis niger niger* (Bartram)

#### Red Wolf

*Distribution.* The red wolf probably ranged throughout Mobile and Baldwin Counties before the area was extensively settled. Howell (15) noted "these wolves apparently were exterminated many years ago" from the big swamp country of Mobile and Baldwin Counties. He reported that the last red wolf of which there is a record was reportedly killed near Carlton about 1894. Carlton was located approximately on the Clarke-Baldwin County line. No evidence of this species was found during this investigation.

*Location of Specimens.* There are no known specimens in existence from Mobile or Baldwin Counties.

### *Vulpes fulva fulva* (Desmarest)

#### Red Fox

*Distribution.* The red fox apparently is not native to the southern states, but the manner in which it got there has never been definitely determined. Audubon and Bachman (1) noted: "In the early history of our country the Red Fox was unknown south of Pennsylvania, that State being its Southern limit. In process of time it was found in the mountains of Virginia, where it has now become more abundant than the Gray Fox. A few years afterwards, it appeared in the more elevated portions of North Carolina, then in the mountains of South Carolina, and finally in Georgia, where we have recently observed it." Howell (15) stated that the red fox had either been introduced into Alabama by fox hunters or it had extended its range into the state. Its occurrence here is probably a combination of both factors. These foxes appear to be widespread throughout both Mobile and Baldwin Counties. Heller (pers. comm.) reported that red foxes were "very plentiful" in Baldwin County during 1968. *Mobile Co.* (FIRST COUNTY RECORD): Bucks, Chunchula, Dawes, Delchamps, Grand Bay. This reportedly occurs at Axis, Bayou La Batre, Creola, Georgetown, Mobile, Tanner-Williams, Theodore and Turnerville. *Baldwin Co.:* Belforest, Blacksher, Gateswood, Magnolia Springs. Holliman (14) reported examining a specimen from this county, but gave no further information. This species reportedly occurs at Barnwell, Bay Minette, Bon Secour, Elberta, Fort Morgan, Gulf Shroes, Perdido, Rosinton, Spanish Fort and Stockton.

*Measurements.* 1 male: total length, 876; tail, 335; hind foot, 148; weight, 6 lb. 2 females: total length, 925 (885-965); tail, 320.5 (261-380); hind foot, 156.5 (155-158); weight (1), 9 lb.

*Location of Specimens.* USA, SU.

### *Urocyon cinereoargenteus floridanus* Rhoads

#### Gray Fox

*Distribution.* The gray fox is widely distributed throughout Mobile and Baldwin Counties. It is more common than the red fox (14) and both

species tend to occur in the same habitat. Heller (pers. comm.) noted that although gray foxes are found throughout Baldwin County, they are more numerous north of U. S. Route 90. Holliman (14) noted that gray foxes have been trapped and released within Alabama by sportsmen to supplement the native stock; this tends to complicate the taxonomic status of *Urocyon*. *Mobile Co.* (FIRST COUNTY RECORD): Dawes, Delchamps, Mobile, Pennsylvania, Tanner-Williams. This species reportedly occurs at Axis, Bayou La Batre, Citronelle, Creola, Grand Bay and Turnerville. *Baldwin Co.*: Belforest, Bon Secour, Bromley, Foley, Gateswood, Latham, Orange Beach, Seminole. This species reportedly occurs at Bay Minette, Fort Morgan, Gateswood, Gulf Shores, Silverhill and Spanish Fort.

*Measurements.* 1 male: total length, 870; tail, 290; hind foot, 132; weight, 11 lb. 4 females: total length, 869.8 (855-882); tail, 318.5 (303-330); hind foot, 132.0 (125-141); weight (3), 7.1 lb. (6.7-7.5 lb). Sex undetermined (1): total length, 900; tail, 260; hind foot, 120.

*Location of Specimens.* USA, USNM, UA.

#### Family URSIDAE

#### *Ursus americanus floridanus* Merriam

#### Black Bear

*Distribution.* Bears undoubtedly ranged over all of Mobile and Baldwin Counties in early times; presently they are more or less restricted to the large swamps bordering the Mobile and Tensaw Rivers. Howell (15) reported that bears were still common in these swamps and that a number were killed there every fall. He noted a male estimated at 500 pounds had been taken in that vicinity in 1911. Howell also stated that bears were occasionally found in the swamps of southern Mobile County and were reported to be fairly numerous near Bayou La Batre. He recorded a large male bear taken in 1915 near Irvington that was estimated to weigh 400 pounds. A single bear was reported in 1905 at Bon Secour - the only one for many years (15). During this study, numerous reports were received of bears in and around the Mobile Delta swamps. The author spoke to a local resident who claims to have killed 18 bears in northeastern Mobile County between 1947 and 1967.

Howell (15) regarded the black bear in southern Alabama as an intermediate between *Ursus americanus floridanus* and *Ursus americanus luteolus*. However, Hamilton (10) showed *floridanus* extending only into the southeastern portion of Alabama and *luteolus* being found west of Mobile Bay in Mobile County. Miller and Kellogg (21) and Hall and Kelson (9) indicated that *floridanus* was found in the swamps of southern Alabama and that *luteolus* was entirely absent from the state. Additional data are needed to determine the geographical limits of the subspecies occurring in southwestern Alabama. *Mobile Co.*: Bayou La Batre, Bucks, Irvington, Mobile. This species reportedly occurs at Axis, Creola, Little Bayou Canot, Mt. Vernon, Pennsylvania, Saraland and Turnerville. *Baldwin Co.*: Bon Secour, Latham, Lillian. This species reportedly occurs at Stockton and in the swamps along the Tensaw River.

## Mammals of Mobile and Baldwin Counties

*Location of Specimens.* USNM, UA.

### Family PROCYONIDAE

*Procyon lotor varius* Nelson and Goldman

#### Raccoon

*Distribution.* Raccoons are one of the most common and best known of the southern mammals. They are distributed throughout Mobile and Baldwin Counties. These animals are found mainly in timbered swamps, river bottoms, along the banks of streams and in the salt marshes along the coast. *Mobile Co.:* Alabama Port (Cedar Point), Citronelle, Dauphin Island, Delchamps, Grand Bay, Little Bayou Canot, Mobile, Mt. Vernon, Wilmer. This species reportedly occurs at Axis, Bucks, Chickasaw, Creola, Pennsylvania, Tanner-Williams, Theodore and Turnerville. *Baldwin Co.:* Barnwell, Bay Minette, Belforest, Blacksher, Bon Secour, Bromley, Elberta, Foley, Gulf Shores, Hurricane, Lottie, Loxley, Magnolia Springs, Marlow, Orange Beach, Perdido Bay, Robertsedale, Rosinton, Spanish Fort, Stockton, and at junction of Tensaw and Middle Rivers. This species reportedly occurs at Fort Morgan, Little Bateau Bayou, Little River, Malbis and Tensaw.

*Pelage.* Albino raccoons have been recorded at Mt. Vernon in March, 1963 (photo in South Alabama Sportsman, October, 1963), from the Rob Boykin Game Management Area just north of Citronelle in Washington County during the fall of 1968 (photo in Mobile Press, February 11, 1969), and in Gulf State Park, Gulf Shores during the winter of 1969.

*Food.* Holliman (14) observed raccoons feeding on oysters and other bivalves near Dauphin Island. He noted that residents of the area reported raccoons drowning in high tides as a result of their toes caught in the bivalve shells.

*Measurements.* 4 males: total length, 713.8 (623-772); tail, 226.5 (210-258); hind foot, 108.0 (105-110); weight (2), 9.5 lb (9.25-9.75 lb). 3 females: total length, 759.0 (672-850); tail, 240.0 (210-280); hind foot, 99.3 (95-105); weight (1), 8.5 lb.

*Location of Specimens.* USA, USNM, UA, SU.

### Family MUSTELIDAE

*Mustela frenata olivacea* Howell

#### Long-tailed Weasel

*Distribution.* The weasel is one of the rarest mammals in southwestern Alabama, only one individual having been recorded prior to this study. That specimen was taken near the Louisville and Nashville Railroad bridge over the Mobile River 12 miles northeast of Mobile in Mobile County. A second specimen was taken on May 19, 1968, on U. S. Route 90 at Halls Mill Creek just outside the Mobile city limits. Howell (15)

stated that this weasel lives in the drier parts of the timbered swamps, making its den usually under the roots of a tree or in a hollow stump. *Mobile Co.*: Mobile, 12 miles northeast of Mobile. *Baldwin Co.* (FIRST COUNTY RECORD): Daphne, Fairhope. This species reportedly occurs at Belforest, Elberta, Foley and Point Clear.

*Measurements.* 3 males: total length, 430.0 (425-440); tail, 136. (117-154); hind foot, 50.3 (50-51).

*Location of Specimens.* USA, USNM, UM.

*Mustela vison mink* Peale and Palisot de Beauvois

#### Mink

*Distribution.* Howell (15) noted that although the mink was generally distributed over most of Alabama, it was very scarce in the southern counties. He noted a series of 12 skulls from the Mobile River swamps and reported that mink occurred rarely at Orange Beach and Bayou La Batre. The University of Alabama Mammal Collection contains two skins and three skulls of this species taken at Bay Minette in Baldwin County. Information gathered during this study from three trappers in northern Baldwin County revealed that they capture several mink each year in their traps. Two specimens were secured during this investigation. One individual was taken near Stockton in Baldwin County and the other was taken on Interstate Route 10 at Halls Mill Creek. Halls Mill Creek forms the southern boundary of the city of Mobile. *Mobile Co.*: Mobile, "Mobile River swamps", Mt. Vernon. This species reportedly occurs at Bayou La Batre, Rattlesnake Bayou near Mobile and Theodore. *Baldwin Co.*: Bay Minette, Latham, Stockton, Tensaw. This species reportedly occurs at Barnwell, Bromley, Hurricane and Orange Beach.

*Measurements.* 3 females: total length, 534.3 (468-615); tail (2) 148.0 (131-165); hind foot (2), 54.5 (52-57); weight (2), 2 lb. (2-2 lb)

*Location of Specimens.* USA, USNM, UA.

*Spilogale putorius putorius* (Linnaeus)

#### Spotted Skunk

*Distribution.* Although Howell (15) and Holliman (14) stated that this skunk occurs commonly throughout most of the state, this is not the case in Mobile and Baldwin Counties. During the current investigation, only one specimen was recorded. This individual was a male taken eight miles east of Citronelle in northern Mobile County. Howell (15) recorded this species only from Mobile. *Mobile Co.*: Citronelle, Mobile. This species reportedly occurs at Axis, Creola and Grand Bay. *Baldwin Co.*: This species reportedly occurs at Bon Secour. Howell (15) noted that it seemed to be unknown at Orange Beach.

*Food.* Howell (15) quoted from a letter from Dr. Charles Mohr, dated June 1, 1890, giving notes on the feeding habits of this species near

Mobile:

"I will give some notes on the habits of the small striped skunk, and in particular describe the manner in which it disposes of the eggs which it is very fond of stealing at its nightly visits to the chicken house.....the skunk is unable to open the egg by the aid of its teeth or to take hold of it with its mouth in order to carry it away. It removes the egg from the nest, rolls it with the front paws to a place presenting a solid, hard surface, then the egg is taken in its paws, the animal assumes an erect posture, lifts it from the ground, then lets it drop from the height of its body to insure its breakage in striking the hard ground."

*Measurements.* 1 male: total length, 495; tail, 160; hind foot, 48; weight 1.75 lb.

*Location of Specimens.* USA, USNM.

*Mephitis mephitis elongata* Bangs

#### Striped Skunk

*Distribution.* In Alabama, this subspecies is apparently restricted to the coastal region (9, 15). Howell (15) examined three specimens from Perdido Bay and provisionally referred skunks reported from Bon Secour, Bayou La Batre, Mobile and Dauphin Island to this subspecies. From October, 1967, to December, 1968, these skunks were apparently scarce in Mobile and Baldwin Counties, as only three specimens were recorded. However, 16 striped skunks were recorded during the period January 17-February 19, 1969. *Mobile Co.* (FIRST COUNTY RECORD): Bucks, Citronelle, Georgetown, Grand Bay, Semmes, Tanner-Williams, Theodore. This species reportedly occurs at Axis, Bayou La Batre, Creola, Dauphin Island, Mobile, Turnerville and Wilmer. *Baldwin Co.:* Belforest, Elberta, Foley, Gulf Shores, Interstate 10 near Perdido River, Lillian, Loxley, Perdido Bay, Rosinton. This species reportedly occurs at Bay Minette, Fairhope, Little River and Marlow.

*Measurements.* 6 males: total length, 668.3 (590-830); tail, 280.2 (241-370); hind foot, 71.5 (70-74). 3 females: total length, 605.0 (568-647); tail, 258.3 (223-310); hind foot, 64.0 (58-69); weight (2), 2.9 lb. (2.7-3.0 lb).

*Location of Specimens.* USA, USNM, BSC.

*Lutra canadensis canadensis* (Schreber)

#### River Otter

*Distribution.* Howell (15) stated that the otter was generally distributed throughout the state, but was perhaps most numerous in the middle and southern counties. He noted that otters lived in the most remote and



unfrequented swamps, streams and ponds and that they were decreasing rapidly everywhere due to persistent trapping. He recorded specimens from Whistler during the winter of 1911-1912, and from the Mobile River near the Louisville and Nashville Railroad bridge in 1917. During this study, one otter skin taken in 1967 from Rattlesnake Bayou (just south of Mobile) was acquired. The Samford University Mammal Collection contains a female otter taken at Magnolia Springs in 1961, while two pelts taken north of the Mobile Causeway and in the possession of private individuals represent the only other evidence of this species from Baldwin County. Several trappers reported taking otter in the vicinity of Tensaw in northern Baldwin County. *Mobile Co.*: Mobile, Seven Hills, Whistler. This species reportedly occurs at Bayou La Batre, Black Creek near Mobile River, Cedar Point, Grand Bay, Mobile Delta region, Satsuma and Tanner-Williams. *Baldwin Co.* (FIRST COUNTY RECORD): Gestang Bay, Little Bateau Bayou, Magnolia Springs. This species reportedly occurs at Barnwell, Bay Minette Creek, Belforest, Blackwater Creek, Bon Secour, Elberta, Fish River, Foley, Gulf Shores, Hurricane, Latham, Magnolia River, Montrose, Orange Beach, Perdido River, Point Clear, Spanish Fort, Spanish River, Stockton, Styx River, Tensaw and Tensaw River.

*Food.* Holliman (14) observed three otters feeding at night in the tidal pools along the Cedar Point Road south of Alabama Port.

*Measurements.* 1 male: total length, 1115; tail, 450; hind foot, 127; weight, 17 lb. 1 female: total length, 870; tail, 300; hind foot, 100.

*Location of Specimens.* USA, USNM, SU.

Family FELIDAE

*Felis concolor coryi* Bangs

Mountain Lion

*Distribution.* Although the mountain lion, or "panther," as this animal is usually called in this area, occurred throughout Alabama in earlier times, it is now nearly, if not completely, extirpated. Howell (15) reported that a mounted specimen was seen near Blakeley in Baldwin County in 1820 and that one of these large cats was reported seen near Hurricane, also in Baldwin County, about 1905. Holliman (14) noted several recent reports of the occurrence of mountain lions from the residents of Mobile and Baldwin Counties, but the reports were never confirmed by specimens. Similar reports have been recorded during this study. One reliable trapper reported he had treed a mountain lion on one occasion in Baldwin County, but that it had escaped. *Mobile Co.*: This species reportedly occurs at Axis, Creola, Grand Bay, Satsuma and Tanner-Williams. *Baldwin Co.*: Blakeley. This species reportedly occurs at Barnwell, Foley, Hurricane, Loxley, Perdido and Stockton.

*Location of Specimens.* There are no known specimens in existence from Mobile or Baldwin Counties.

# Mammals of Mobile and Baldwin Counties

## *Lynx rufus floridanus* Rafinesque

### Bobcat

*Distribution.* The bobcat occurs throughout both counties, although it seems to be more abundant in Baldwin County than in Mobile County. An experienced trapper from Baldwin County (Heller, pers. comm.) stated that bobcats were most numerous from Pirates Cove to the extreme northern end of the county and in the area bounded by the Fort Morgan highway, U. S. Route 98 and Alabama Route 59. He further noted that bobcats could be found in almost any area of swampy timber throughout Baldwin County. A state game warden reported in May, 1969, that bobcats were increasing in numbers in Mobile County. *Mobile Co.:* Theodore. This species reportedly occurs at Axis, Citronelle, Creola, Georgetown, Grand Bay, Mobile, Mt. Vernon, Saraland, Satsuma and Wilmer. *Baldwin Co.:* Bromley, Elberta, Fairhope, Foley, Fort Morgan, Gulf Shores, Hurricane, Latham, Lillian, Orange Beach, along the Perdido River and Stockton. This species reportedly occurs at Barnwell, Bay Minette, Crab Creek, Little River, Perdido Bay, Rosinton and Spanish Fort.

*Food.* Davis (6) examined the stomachs of 11 bobcats from this area and recorded the following food items:

#### Baldwin County - 4 stomachs

<i>Food Item</i>	<i>% Freq.</i>	<i>% Vol.</i>
<i>Gallus domesticus</i> (poultry)	25	14.3
<i>Peromyscus</i> sp.	25	3.7
<i>Neotoma floridana</i>	25	4.9
<i>Sylvilagus</i> sp.	50	39.3
<i>Odocoileus virginiana</i>	25	37.7

#### Mobile County - 7 stomachs

<i>Meleagris gallopavo</i> (wild turkey)	14.3	12.0
<i>Sylvilagus</i> sp.	57.1	59.5
<i>Odocoileus virginiana</i>	28.6	28.5

*Measurements.* 1 female: weight, 17 lb. Sex undetermined (3): weight, 26.7 lb. (24-32).

*Location of Specimens.* USA, USNM.

#### Order ARTIODACTYLA

#### Family CERVIDAE

*Dana virginiana virginiana* Zimmermann

*Dana virginiana osceola* (Bangs)

#### White-tailed Deer

*Distribution.* Deer are relatively abundant throughout Mobile and Baldwin Counties, particularly in the large timber tracts in the northern portion of Baldwin County. In 1921, Howell (15) reported that the only part of the state where deer were still abundant was in the big wooded swamps of the lower Tensaw and Mobile Rivers. He reported moderate numbers of deer in southern Baldwin County. However, in Mobile County, he noted "Twenty years ago or more they were common in the sandhills and small swamps of Mobile County, but now apparently all have been exterminated from that region." Specimens from Orange Beach, Gravine Island and Mt. Vernon Barracks were examined by Howell who concluded they belonged to the subspecies *virginiana*. However, Miller and Kellogg (21) extended the range of *osceola* westward and northward to cover most of Mobile and Baldwin Counties. This range is currently recognized by Hall and Kelson (9). Haugen (12) regarded deer from southwestern Alabama as belonging to the subspecies *osceola*. *Mobile Co.:* Bucks, Citronelle, Creola, Wilmer. This species reportedly occurs at Axis, Chunchula, Dawes Grand Bay, Mobile, Mobile Delta, Mt. Vernon, Pennsylvania, Saraland, Tanner-Williams, Theodore and Turnerville. *Baldwin Co.:* Bay Minette, Blacksher, Foley, Gateswood, Orange Beach, Perdido Bay, Rosinton, Spanish Fort, Summerdale, swamps of the Tensaw and Mobile Rivers. This species reportedly occurs at Elberta, Gulf Shores, Hurricane, Lottie, Perdido, Robertsedale, Stockton and Tensaw.

*Reproduction.* A fawn was observed near Citronelle on January 29. Two newly-born fawns have been recorded in September - one from Le Moyne and the other from Wilmer.

*Predation.* Deer were recorded from bobcat (*Lynx rufus*) stomachs taken in Mobile and Baldwin Counties (6).

*Location of Specimens.* USA, USNM.

#### ACKNOWLEDGEMENTS

Thomas W. Meyer, chief research assistant since the inception of this study, was involved primarily with the trapping program as well as with specimen preparation and data tabulation. Miss Susan H. Rouillier assisted in the preparation of specimens, the tabulation of data, and the typing of the manuscript. Finally, my wife, Alicia, spent many hours confirming species identifications, tabulating data, and critically evaluating the manuscript.

This study was financed in part through University of South Alabama Faculty Research Grants 1-6370 and 1-6397.

#### LITERATURE CITED

1. Audubon, J. J. and J. Bachman. 1846-1854. The viviparous quadrupeds of North America. 3 vols. New York.
2. Bowen, W. W. 1968. Variation and evolution of Gulf Coast populations of beach mice, *Peromyscus polionotus*. Bull. Fla. State Mus. 12(1):1

# Mammals of Mobile and Baldwin Counties

3. Cole, L. C. and J. A. Koepke. 1946. A study of rodent ectoparasites in Mobile, Ala. Pub. Health Rep. 61: 1469-1487.
4. Colin, W. 1957. An Alabama squirrel study. Ala. Cons. 29(4):24-27.
5. Comings, L. J. N. and M. M. Albers. 1928. A brief history of Baldwin County. Baldwin Co. Historical Society, Fairhope, Ala. 91 pp.
6. Davis, J. R. 1955. Food habits of the bobcat in Alabama. MS Thesis, Auburn Univ. 79 pp.
7. Fitch, H. S., P. Goodrum, and C. Newman. 1952. The armadillo in the southeastern United States. J. Mammal. 33(1):21-37.
8. Goldman, E. A. 1910. Revision of the wood rats of the genus *Neotoma*. N. Amer. Fauna 31:1-124.
9. Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Co., New York. 1083 pp.
10. Hamilton, W. J., Jr. 1943. The mammals of eastern United States. Comstock Publ. Co., Inc., Ithaca, New York. 432 pp.
11. Haugen, A. O. 1955. Beaver longevity. Ala. Cons. 26(5):16.
12. \_\_\_\_\_. 1959. Breeding records of captive white-tailed deer in Alabama. J. Mammal. 40(1):108-113.
13. Holliman, D. C. 1959. Studies on the taxonomy, distribution and ecology of the cottontail rabbit (*Sylvilagus floridanus*) in Alabama. MS Thesis, Univ. of Ala. 51 pp.
14. \_\_\_\_\_. 1963. The mammals of Alabama. Ph.D. Thesis, Univ. of Ala. 316 pp.
15. Howell, A. H. 1921. A biological survey of Alabama. N. Amer. Fauna 45:1-88.
16. Linzey, D. W. and A. V. Linzey. 1969. First record of the yellow bat in Alabama. J. Mammal. 50(4):845.
17. Lowery, G. H., Jr. 1943. Check-list of the mammals of Louisiana and adjacent waters. Occas. Papers Mus. Zool., Louisiana State Univ. 13:213-257.
18. Lueth, F. X. 1949. Meet Mr. and Mrs. Nutria. Ala. Cons. 20(12): 4, 22.
19. Martin, E. C. 1947. The muskrat comes back. Ala. Cons. 18(8):9,13.
20. McWilliams, R. G. 1955. Armadillo - Alabama's armored pig. Ala. Cons. 26(4):8-9, 21, 23.

21. Miller, G. S., Jr. and R. Kellogg. 1955. List of North American recent mammals. Bull. U. S. Nat. Mus. 205:1-954.
22. Nelson, E. W. 1909. The rabbits of North America. N. Amer. Fauna 29: 1-314.
23. Price, R. F. 1964. Beaver creates problem for Alabama landowners. Ala. Ccns. 34(5):9-12.
24. Richardson, J. M. 1965. Alabama Encyclopedia. The American Southern Publ. Co., Northport, Ala. 1051 pp.
25. Royal, O. L. 1952. A preliminary survey of the insect ectoparasites of the mammals of Alabama. MS Thesis, Univ. of Ala. 128 pp.
26. Sanford, L. G. 1963. Geographic variation in the gray squirrels of Alabama. MS Thesis, Auburn Univ. 82 pp.
27. Schwartz, A. and E. P. Odum. 1957. The woodrats of the eastern United States. J. Mammal. 38(2):197-206.
28. Taber, F. W. 1939. Extension of the range of the armadillo. J. Mammal. 20(4):489-493.
29. U. S. Dept. of Agriculture. 1969. Monitoring agricultural pesticide residues 1965-1967. Agric. Res. Service Report No. 81-32. Washington, D. C. 97 pp.
30. Wallace, J. H., Jr. 1916. The mammals of Alabama. Fifth Bien. Rept., Dept. Game and Fish, Montgomery. pp. 8-21.
31. White, J. S. 1959. The acarine ectoparasites of Alabama bats. Ph.D. Thesis, Univ. of Ala. 137 pp.
32. Williams, B. H., G. A. Swenson, M. J. Edwards, and A. L. Gray et al. 1936. Soil Survey of Mobile County, Alabama. U. S. Dept. of Agriculture Series 1930, No. 42. 47 pp.
33. Zambenardi, J. 1956. Woodrats of the genus *Neotoma* in Alabama. MS Thesis, Univ. of Ala. 48 pp.

PROPAGATION OF HIGH INTENSITY, HIGH VOLTAGE ELECTRON BEAMS

T. G. Roberts  
U.S. Army Missile Command  
Redstone Arsenal, Alabama

INTRODUCTION

Recently, it has become possible to produce relativistic electron beams with powers in the range from  $10^{10}$  to  $10^{13}$  watts and the propagation of such beams in several media has been studied experimentally. However, there is no complete theory for this phenomenon even though theories for the propagation of certain intense beams in some media were developed long before it became possible to perform the experiments.

The first theory of the propagation of self-focusing relativistic beams was developed as early as 1934 by Bennett (2). Due to the interest created by Project Sherwood, Bennett published another paper on this problem in 1955 (3) and Bennett and Hulbert (4) applied this theory to proton streams traveling from the sun towards the earth in an attempt to account for the aurora. Budker (6) used this theory to predict that these beams could be used in a small radius high energy accelerator for heavy ions. Budker emphasized the importance of the specific electromagnetic radiation which is produced by the beam particles moving in the beams own fields. This factor had been neglected by Bennett. Lawson (11, 12) treated a highly idealized model of a relativistic electron beam which he claimed to be a possible intermediate state in setting up a beam of the form described by Budker. A theory for the stability of these beams propagating in metal cylinders was also developed by Finkelstein and Sturrock (8).

Even though the above theories received much attention, experimental information was nonexistent until 1965 when tens of thousands of amperes at several million volts were extracted from the electrode space of a flash X-ray machine and injected into the end of a plasma column (14). The injected beam traveled 23 cm in the ionized medium without space charge blow up. Since these early experiments, many experiments have been performed where these beams were injected into both field free drift spaces at different ambient pressures (7,9,13) and into ionized media of different lengths (5, 15, 16, 17, 18, 19, 20). These beams have been made to propagate in metal tubes and ionized columns which were bent into various shapes, that is, the media can be made to serve as a guide for the relativistic electron beams. One important result of the experiments which was not recognized by any of the theories was the importance of the induced return current on the behavior of the injected electron beams (20).

Enough information has now been obtained so that a phenomenological description of the propagation of high intensity relativistic electron beams can be made. It is the purpose of this paper to describe the principle results of the existing experiments and theories and to develop a phenomenological description for the propagation in various media.



## EXPERIMENTAL RESULTS

Two different methods have been developed for producing high current pulses of electrons at relativistic energies. In one of these<sup>1</sup> a Van deGraaff generator charges a three meter long coaxial capacitor whose central electrode is an extension of the terminal of the generator column. A potential of several megavolts is accumulated on the terminal and a triggered spark gap on the symmetric axis of the terminal is used to deliver the energy to the high voltage electrode of the discharge tube. Supported from this electrode is a cold cathode, and the sudden application of the high negative potential to this cold cathode produces field emission of more than 20,000 A at more than 2 MV for pulses of the order of 20 nsec.

In the other method,<sup>2</sup> three coaxial cylinders are used as illustrated schematically in Figure 1. One end of the inner cylinder is connected to the high voltage terminal of the discharge tube, A. The rounded end of the intermediate cylinder is close to the rounded end of the inner cylinder. The outer cylinder is the wall of the cylindrical tank which is filled with oil everywhere except in the discharge tube.

A reflex surge generator, M, is used for charging the middle cylinder in a time of the order of a tenth microsecond, and this greatly over-volts the spark gap at the rounded end of the intermediate cylinder. The release of the charge between the middle cylinder and the inner cylinder and between the middle cylinder and the outer cylinder is like the discharge of the transmission lines of a Blumlein circuit as shown in Figure 2. As soon as the wave has passed from the gap to the other end of the inner cylinder, at A, which is connected to the discharge tube, T, the voltage across the discharge tube rises from zero to some voltage less than twice the initial potential to which the middle cylinder was charged. The pulsed high voltage is applied to the cold cathode, K, in the discharge tube as illustrated in Figure 1. The application of this very high potential, V, between the cathode and the flat anode draws a very high current of field emission electrons from the cathode which may be emitted in a widely divergent beam very irregularly distributed both in direction and in time during the pulse. This type of machine has been made to produce pulses of 100,000 A at 12 MV for  $4 \times 10^{-8}$  sec or of 500,000 A at several hundred kilovolts for  $4 \times 10^{-8}$  sec. This type of machine was used in the following experiments.

## PROPAGATION IN AN IONIZED MEDIUM

In order to inject the intense pulse of relativistic electrons into the ionized medium, the thick central portion of the anode of the high

<sup>1</sup>Nablo, S. V. Ion Physics Corp., Burlington, Mass. Personal communications.

<sup>2</sup>Martin, D. Physics International Co, San Leandro, Calif. Personal communications.

voltage tube was replaced with a thin metal sheet F. A linear pinch discharge in argon was coupled to the anode as shown schematically in Figure 1. The linear pinch used had a glass tube which was four inches in diameter and the plasma column length could be varied from a few inches to 6 feet. Typical operating conditions for the linear pinch were: the total circuit inductance was of the order of  $10^{-6}$  henry, the initial mass density of the argon was  $1.7 \times 10^{-8}$  gm/cm<sup>3</sup> which corresponds to a particle density of  $10^{15}$  particles/cm<sup>3</sup>, the voltage across the capacitor bank was of the order of  $1.5 \times 10^4$  volts, the rate of increase of current was of the order of  $3 \times 10^{10}$  amps/sec., the time to pinch was of the order of  $1.6 \times 10^{-6}$  sec., the average sheath velocity was  $3.6 \times 10^6$  cm/sec, and the current at the time of the pinch was of the order of  $5 \times 10^4$  amps. The pulse of relativistic electrons was usually injected into the plasma column before the linear pinch had reached a minimum radius for the first time. However, during some experiments the relativistic electron beam was injected when the plasma diameter was a minimum and also after the plasma had thermalized and the plasma diameter was expanding. The results obtained when the plasma diameter was a minimum were different than those reported here and will be discussed elsewhere.<sup>3</sup>

The plasma current in the linear pinch was in such a direction that its magnetic field prevented the high voltage electrons from striking and destroying the glass wall, but instead turned them back into the plasma column. The injected beam pinched itself to a radius which was smaller than that of the plasma while propagating to the far end of the linear pinch tube. Damage to the target which was embedded in the electrode of the linear pinch indicated that most of the energy in the injected pulse, which at times was as high as  $10^4$  Joules, had been delivered to the target. This is illustrated in Figure 3 which is a photograph of an Inconel target which was hit with about  $5 \times 10^4$  amps at about  $5 \times 10^6$  volts for approximately  $4 \times 10^{-8}$  sec. Note that the rapid loading of the front surface with this kind of impulse produced a momentum wave in the material which was strong enough to cause the back surface to spall. It should be pointed out that the injected beam seemed to lose negligible energy in propagating the length of the plasma column. That is, the extent of the target damage seemed to be the same whether the plasma column was a few inches or six feet in length.

Because of the effect of the magnetic field of the plasma current on the high energy electrons it was felt that the plasma column could be used as a guide for the injected beam. However, to perform these experiments it was necessary to produce a curved plasma column which was at least as stable as the straight plasma columns during the time of passage of the injected beam, and for future work it was required that the curved plasma column remain stable after passage of the beam. That is, the transport of the injected beam around the curve must not cause a perturbation which drives the plasma column unstable. A simple method for producing such a curved, stable plasma column was devised by tailoring the current distribution so that the linear pinch discharge was partially back-strapped only on the curved portion. Thus, the high voltage beam was injected into a plasma column which contained a 90 degree turn on a

<sup>3</sup>Roberts, T. G. and W. H. Bennett. Unpublished.

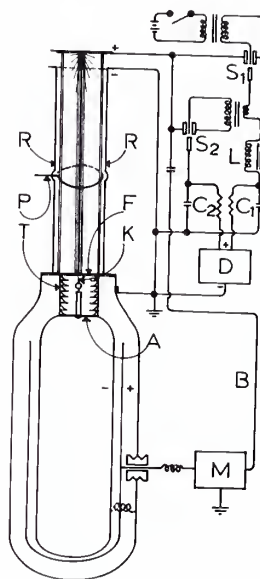


FIGURE 1. Schematic of the experimental arrangement.

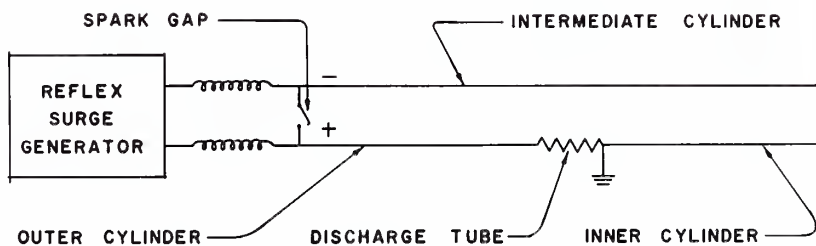


FIGURE 2. Schematic of Blumlein circuit corresponding to the operation of the high voltage machine.

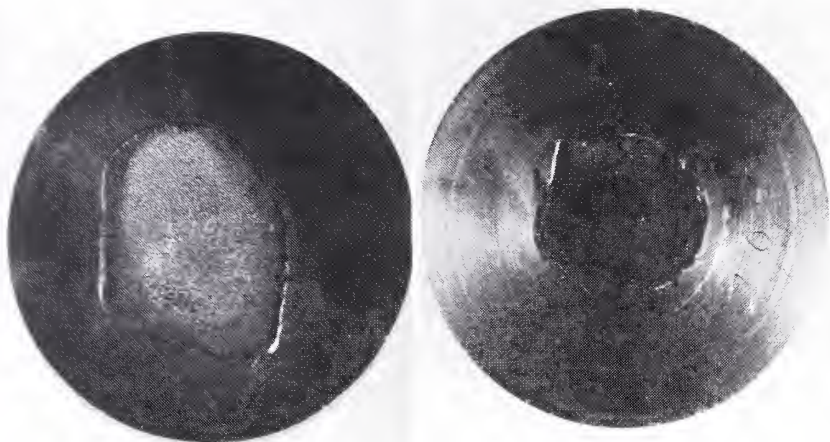


FIGURE 3. Damage to Inconel target 38 mm in diameter and 4.8 mm thick, impacted with a 50,000 amp, 5 Mev,  $3 \times 10^{-8}$  sec. beam.

six inch radius, and it was found that the beam was guided around the bend with only a little loss of total energy. Figure 4 shows two targets which were obtained with similar beams. The one on the left was located only 18 inches from the anode with just a straight pinch while the one on the right was impacted after the beam had propagated around the curve and had covered a distance of 4.5 feet. It may be seen from the magnitude of the back spall that only a small loss of energy occurred. The injected beam here was about  $3 \times 10^4$  amps at about 3 MV, and the plasma column which was used is shown in Figure 5.

#### THEORY

Bennett's original model was a collision-free beam in which the electrons have a constant drift velocity and a small transverse velocity assumed to be maxwellian. He later generalized the model to include streams with any distribution in radius and in transverse momenta, and with other than complete space charge neutralization. Using this model he calculated the transverse density distribution that the beam must assume. His treatment was relativistically invariant and the following important physical properties of such streams were stressed: a. There is a critical current that must be exceeded if the beam diameter is to contract. b. Streams containing both slow and fast particles of like





FIGURE 4. Two targets cut to show the magnitude of the back spalls, left target from a straight tube and right target from a curved tube. Similar beams were launched toward both targets.

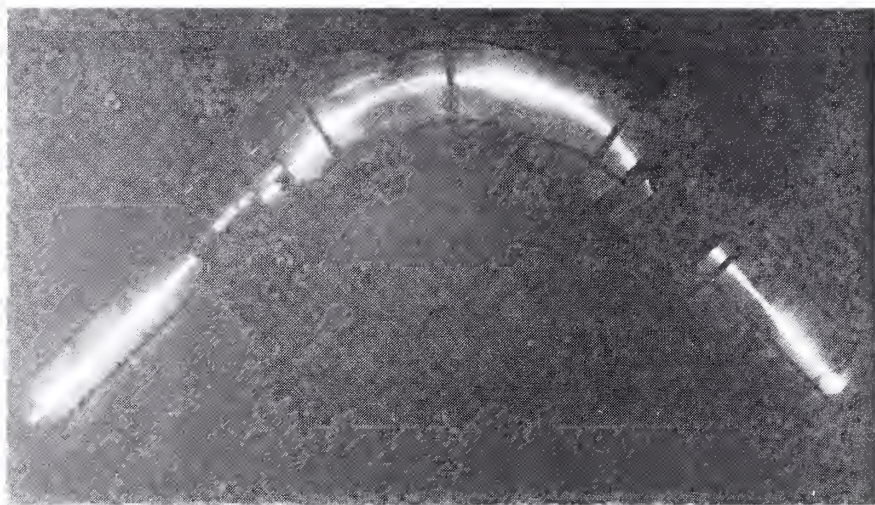


FIGURE 5. Time integrated photograph of pinch plasma in curved tube which was used to guide the high voltage electron beam.

kind tend to eject the slow particles and keep the fast ones in order to establish space charge neutralization. c. Streams of particles of one kind only entering an ionized medium can be self-focusing if the critical current is exceeded. d. These streams are stable against kinks.

The critical current is related to the number of electrons per unit length,  $N$ , of the beam; the average kinetic energy per particle,  $\Psi$ , due to momenta transverse to the direction of the beam; and the total net charge,  $q$ , per unit length of the beam by

$$I = c(2N\Psi + q^2)^{\frac{1}{2}}, \quad (1)$$

where  $c$  is the velocity of light.

Lawson used paraxial beam analysis to study a highly idealized model of a relativistic electron beam which was claimed to be a possible intermediate state in setting up a beam of the form described by Budker. Lawson's model neglected axial magnetostatic forces and angular momentum properties and yielded sinusoidal electron motions with a characteristic wavelength

$$\lambda = 2\pi b/(-K)^{\frac{1}{2}}$$

where  $b$  is the initial beam radius, and  $K$  is the relativistic or generalized perveance which is negative. In another paper Lawson related the relativistic perveance,

$$K = \frac{2v}{\beta^2\gamma} (1 - \beta^2 - f)$$

where  $v = Ne/mc^2$ ;  $\gamma = (1 - \beta^2)^{-\frac{1}{2}}$ ,  $\beta = \frac{v}{c}$ , and  $f$  is the charge density ratio, to the Bennett relation for the critical current. Lawson also pointed out that the transverse oscillations represented by  $\lambda$  would be damped out by interaction with the back ground ions or by the application of an accelerating voltage.

#### DESCRIPTION OF BEAM PROPAGATION

For streams containing fast electrons and slow moving singly-charged ions such that a fraction,  $f$ , of the electron space charge is neutralized by  $f \cdot N$  ions per unit length of the stream, the net charge per unit length can be written

$$q = -eN(1-f), \quad (2)$$

and the critical current for the pinch effect becomes

$$I = c[(1+f)N\Psi + e^2N^2(1-f)^2]^{\frac{1}{2}}. \quad (3)$$

There is a value of the critical current,  $I_0$ , for the pinch effect when all the space charge is neutralized

$$I_0 = \frac{2c^2}{ev} \Psi \quad (4)$$



where  $v$  is the beam electron velocity. But, if  $f \neq 1$ , the portion of the critical current which is required to just balance the expansion due to transverse energy alone is given by

$$I_2 \equiv e[(1+f) N \Psi] \quad (5)$$

The current  $I_2$  is a function of  $f$  and is never less than  $I_0/\sqrt{2}$  nor greater than  $I_0$  and  $I_2 = I_0$  when  $f = 1$ . The minimum fractional part of the space charge which must be neutralized can be written in terms of  $I_2$  as

$$f = 1 - \frac{v}{c} \left( 1 - \frac{I_2^2}{I_0^2} \right)^{\frac{1}{2}} \quad (6)$$

Thus, a fully neutralized beam ( $f = 1$ ) in which  $I$  exceeds  $I_0$  is a non-steady situation and the beam will contract in diameter or pinch while  $\Psi$  increases so that  $I_0 \rightarrow I$ . This is  $\Psi \rightarrow Ne^2/2 \cdot \beta_{||}^2$  or  $\frac{1}{2} \gamma mc^2 B_{\perp}^2 \rightarrow Ne^2/2 \cdot \beta_{||}^2$  and at equilibrium

$$\beta_{\perp}^2 = \frac{v}{\gamma} \beta_{||}^2 \quad (7)$$

where  $\beta_{||}$  is associated with the electrons velocity component parallel to the beam,  $\beta_{\perp}$  is associated with the electrons velocity component perpendicular to the beam, and  $v$  is defined as the number of particles per unit beam length multiplied by the classical electron radius  $r_0 = e^2/mc^2$

$$v = r_0 N = r_0 \int_0^{\infty} e(r) 2\pi r dr. \quad (8)$$

For  $v = 1$ , the number of electrons per unit length of the beam is  $r_0^{-1}$  or  $3 \times 10^{12}$  and the current in the beam is approximately 17,000 amperes. Thus, for beams with  $v > 1$ , it follows that the beam particles may have large transverse energies when an equilibrium radius is reached.

Equation (7) gives the limit for applicability of the theory to nondriven beams as

$$\frac{v}{\gamma} < 1. \quad (9)$$

This limit is a result of Bennett's assumption that the beam particles have a small transverse energy compared to their downstream energy initially, and in Lawsons treatment it is a result of his assumption that the orbits of the beam particles never deviate far from the axis. It is sometimes stated that equation (9) requires the Larmor radius of an electron at the beam edge to be much larger than the beam radius, or that the number of electrons per classical electron radius, measured in the rest frame of the electrons, should be small compared with unity. The limit  $v/\gamma = 1$  is called the Alfvén limit (1) which determines the maximum current which such beams may possess. However, beams with  $v/\gamma > 1$  have been produced experimentally (10,21). It must be remembered that the limit  $v/\gamma = 1$  applies only to beams whose space charge is

exactly neutralized which, for the beams now produced, can occur at most in only one reference frame. In the lab frame these beams should possess a net negative charge per unit length, and it has been shown<sup>4</sup> that the current limit for these beams is determined by the condition

$$\frac{v}{Y} \frac{I^2}{I^2} = 1. \quad (10)$$

Equation (10) shows that beams with  $\frac{v}{Y} > 1$  can propagate, and that the beams reported in reference 21 should have propagated in the lab frame.<sup>4</sup>

A program is being set up to calculate the orbits of the electrons as function of their initial radial position for beams which possess a net negative charge per unit length.

#### LITERATURE CITED

1. Alfven, H. 1939. On the motion of cosmic rays in interstellar space. Phys. Rev. 55: 425.
2. Bennett, W. H. 1934. Magnetically self-focusing streams. Phys. Rev. 45:890-897.
3. Bennett, W. H. 1955. Self-focusing streams. Phys. Rev. 98:1584-1593.
4. Bennett, W. H. and E. O. Hulburt. 1954. Theory of the aurora based on magnetic self-focusing of solar ion streams. Phys. Rev. 95:315.
5. Bennett, W. H. and T. G. Roberts. 1967. Theory of intense pulsed beams at relativistic energies. Bull. Am. Phys. Soc. 11:481.
6. Budker, G. J. 1956. Relativistic stabilized electron beam. I. Physical Principles and Theory. CERN Symposium on High Energy Accelerators and Pion Physics 1:68-75.
7. Creedon, J. 1967. Pressure dependence of the pinched electron beam mode. Physics International Co., Report PIIR-17-67.
8. Finkelstine, D. and P. A. Sturrock. 1961. Stability of relativistic self-focusing streams. Plasma Physics. McGraw-Hill Book Co., Inc., New York.
9. Graybill, S. E. and S. V. Nablo. 1966. Observation of magnetically self-focusing electron streams. App. Phys. Letters 8:18-20.
10. Graybill, S., J. Uglorn and S. V. Nablo. 1968. Bull. Am. Phys. Soc. 13:56.
11. Lawson, J. D. 1957. On the adiabatic self-constriction of an accelerated electron beam neutralized by positive ions. J. Electron Control 3:587-594.

---

<sup>4</sup> Roberts, T. G. and W. H. Bennett. Unpublished.

12. Lawson, J. D. 1958. Perveance and the Bennett pinch relation in partially neutralized electron beams. J. Electron Control 5:146-151
13. Link, W. T. 1967. Electron beams from  $10^{11}$ - $10^{12}$  watt pulsed accelerators. IEEE Transactions on Nuclear Science, 777.
14. Roberts, T. G. 1965. The experimental verification of self-focusing in intense, relativistic, electron beams. USAMICOM Report No. RR-TR-65-17.
15. Roberts, T. G. 1966. Experimental studies of the Bennett pinch. USAMICOM Report No. RR-TR-66-16.
16. Roberts, T. G. 1967. Guiding of self-focused relativistic electron beams. USAMICOM Report No. RR-TR-67-16.
17. Roberts, T. G. and W. H. Bennett. 1966. Experimental studies of the relativistic pinch. Autumn Meeting, Nat. Acad. Sci.
18. Roberts, T. G. and W. H. Bennett. 1966. Experimental studies of the relativistic pinch. Bull. Am. Phys. Soc. 11:843.
19. Roberts, T. G. and W. H. Bennett. 1967. Experiments with intense beams at relativistic energies. Bull. Am. Phys. Soc. 11:481.
20. Roberts, T. G. and W. H. Bennett. 1968. The pinch effect in pulsed streams at relativistic energies. J. Plasma Phys. 10:381-389.
21. Yonas, G. and P. Spence. 1968. Experimental investigation of high  $v/\gamma$  electron beam transport. PIFR-106, (DASA 2175).

## Old China Trade Revisited

Curtis T. Henson, Jr.  
History Department  
Auburn University, Auburn, Alabama

In 1757, the emperor Ch'ien-lung issued an edict restricting foreign trade with China to the single port of Canton, thus initiating a unique system of commercial relations. Not only did the Chinese dictate the port of entry for foreign goods, but they also regulated every aspect of the trade as well as the lives of those who engaged in it. The procedures which developed at Canton during the ensuing decades gave character to what came to be known as the old China trade. Participants in this remarkable venture included the major trading nations of western Europe--England, France, Holland, Spain, Sweden, and Denmark. The Americans made their appearance in 1784.

Several features of the old China trade deserve particular comment. In the first place, no treaty existed between China and the nations trading with her. Peking made all the decisions relating to the conduct of trade and enforced them unilaterally. Motivation for the trade was almost completely one-sided. China had little interest in and much contempt for commerce as such; she condescended to sell to the foreigner, but Chinese demand for foreign products was limited. Western desire for Chinese goods, however, led some officials to infer that the foreigner came to China out of necessity. "Inquiries have served to show," memorialized one magistrate, "that the foreigners, if deprived for several days of the tea and rhubarb of China, are afflicted with dimness of sight and constipation of the bowels, to such a degree that life is endangered."<sup>1</sup> These afflictions, if present, more likely resulted from the Westerners' encounters with the myriad official and unofficial exactions they were expected to pay for the privilege of trading. In the absence of treaties, these levies abounded, varying from season to season and from one official to another. Finally, the prices paid by the foreign merchants for Chinese goods, as well as the prices received for their own, were exclusively determined by a select group of Chinese merchants who enjoyed a monopoly on commercial transactions.

Despite the apparent disadvantages, the foreigners eagerly sought a share of the China trade. The Western demand for Chinese goods plus the potential of the vast China market drew the traders to Canton year after year. There, from October until March, the trading ritual was enacted, and the environs of this great metropolis, called CAN-ton by the foreigners, furnished the setting for the old China trade.<sup>2</sup>

The trading community at Canton was restricted to a plot of land some 1100 feet wide, extending back about 700 feet from the Pearl River. On this lot stood 13 factories or "hongs" which served as combination warehouses and living quarters for the various merchants. These huge buildings were divided into three sections, each of which was assigned to one of the foreign mercantile firms. Most of the factories were named after the nations trading there, while the remainder bore Chinese or geographic names. Between the factories and the river was a large square, two customs stations, and a projection of land known as Jackass Point. Concerning this latter landmark, one resident wrote: "No one in

my day knew the origin of the singular name of the Point; it was probable in its being a general resort for a breath of fresh air, and for gossip over the topics of the day."<sup>3</sup> A major thoroughfare called Thirteen Factories Street ran along the rear of the factories and was the principal shopping district outside the city walls.<sup>4</sup>

The factories were divided at intervals by three streets which ran between them and terminated at Thirteen Factories Street. Most notorious was Hog Lane, an appropriately named passage whose offerings drew the foreign sailors in droves. After slaking their thirst, the sailors, according to one English observer, maintained a "continual uproar with their drunken frays and frolics." "If the Chinese judge of Europeans by the scenes of daily occurrence in this locality," he continued, "they are certainly justified in setting them down as the most brutalized of barbarians, and in restraining all . . . connexion with them as much as possible."<sup>5</sup> Further along, Old China Street provoked comment only for its extraordinary width--twelve feet.<sup>6</sup> It ended in the courtyard of the consoo house, which contained the business offices of the Chinese merchants' monopoly or co-hong. Toward the end of the old China trade, the consoo house also served as a vaccination center for native children. This, then, was the Western commercial foothold in China, gateway to the wealth of this vast and mysterious empire.

Restriction of trade to a single port in no way lessened the complexity of dealing with China. Merchant ships entering Chinese waters were immediately confronted with a maze of duties, taxes, and regulations. A bewildering array of individuals always seemed to be involved, at a price, in some part of the trade. Upon reaching the mouth of the Pearl River, the ships took aboard pilots to guide them to their final anchorage at Whampoa, twelve miles below Canton. From Whampoa the cargoes were transported to Canton in small boats, and purchased goods were brought down the river in return. A small foreign community lived there during the trading season. "Anchored in various places were floating stores for ship supplies, a hospital and a French missionary school, and a chapel [where James Beecher, brother of Harriet Beecher Stowe, served as pastor]. Before a ship reached Whampoa, it was required to obtain official permits or "chops," at various points along the route to certify its engagement in legal trade. This practice added more silver to the coffers of Chinese officialdom.

The agent of each ship arriving at Whampoa began by securing the services of one of the co-hong. The hong merchants, whose number varied downward from a maximum of 13, held exclusive right to trade with the foreigner and handled all transactions of buying and selling. They were responsible to the Chinese government for the foreigners' behavior and were the only channel of communication between the foreigners and that government. Their integrity in business relations was widely admired. The American merchant, John Murray Forbes, wrote, "I never saw in any country such a high average of fair dealing . . ."<sup>9</sup> Each ship also had to engage the services of a linguist for communication and a comprador to furnish supplies.<sup>10</sup> Representing the Chinese government as overall supervisor of trade was the hoppo, who issued the grand chop, or permission to leave China.<sup>11</sup>

The outward bound ships carried a variety of cargo, principally tea, silk, and cotton nankeen cloth. In exchange, the foreigners brought to China items representing their own special products. English ships carried lead, woollens, and Indian cotton, while the Americans, who occupied second place in the volume of trade by 1800, brought gensing and later furs. Because China enjoyed a favorable balance of trade, silver constituted a significant portion of her imports.

In order to regulate this flow of trade and the foreigners who were involved with it, the Chinese government instituted a set of rules known as the Eight Regulations. Not all of these were rigidly enforced, but they did severely limit the activities of the foreigners in China. Two of the rules were seldom relaxed. One barred warships from the river, and the other forbade the foreigners from bringing either women or guns to the factories. John Murray Forbes wrote in 1834 that "Canton had just been opened to foreign ladies, but it was very unusual for any to accompany their husbands."<sup>12</sup> Other regulations varied widely in the degree of their enforcement. The merchants could not legally employ Chinese servants, but all of them did. Sedan chairs were forbidden, as lending too much dignity to the barbarians. Pleasure cruises on the river were also forbidden, except for certain specified days when small groups of foreigners might cross the river and console themselves in the flower gardens there. When the trading season ended, all foreigners were required to leave Canton and either return home or settle in Macao for the summer. Most disadvantageous was the rule requiring all official communications to pass through the co-hong. As one historian of the period has observed, "This required [the foreigners] to complain of any irregularity through the agent committing the irregularity."<sup>13</sup> However, in the absence of formal treaty relations, no other avenue of communication was open to the foreigners.

Within the framework of these regulations, the foreigners' life at Canton passed rather easily. The exotic environment and the demands of business combined to soften the repressive measures. Memoirs of participants in the old China trade usually displayed a fondness for the sights and sounds of the Cantonese scene. Prior to 1822 a fence enclosed the square fronting the factories; it was destroyed by fire, and thereafter the square became the gathering place for Chinese entrepreneurs who hawked their various wares to the foreigners and to each other. Loafers also found the square agreeable as did a multitude of beggars. The American merchant William C. Hunter described the mendicants' shuffling entry from Hog Lane and their stately procession in front of the factories. "They followed one another in Indian file, each holding on to his leader. As they advanced they struck the stone pavement with their sticks, keeping up a most doleful grunting, alternating with tremulous appeals of 'Cash, foreign devils, cash!'"<sup>14</sup> When the crowds in the square became a nuisance, word was sent to the military guardhouse, from which soldiers would come to clear the square. The soldiers patrolled the factory area at night, blowing loudly on conch-shell horns to warn potential burglars.<sup>15</sup>

Personal relations between the foreigners and native population were usually cordial. Convinced of their own superiority, the Chinese normally referred to the strangers in their midst as "fankwae," or



"foreign devils." The official designation was equally precise if less graphic, being simple "barbarian." These terms were regarded in the 18th century as a mark of contempt but were common enough later to be accepted on both sides without particular emphasis. John Murray Forbes, recounting in his diary a late afternoon excursion across the river, comments on this facet of Sino-Western relations. "We land there at five in a sort of suburb, saluted by men, women, and children with 'Hillo (sic.), you foreign devils!'"<sup>16</sup> In this context, the name merely served to underscore the relative status of two civilizations. Actions taken by the Chinese government to guarantee the foreigners' safety illustrate the paternalistic attitude behind these appellations. "In no part of the world," wrote William C. Hunter, "could the authorities have exercised a more vigilant care over the personal safety of strangers who of their own free will came to live in the midst of a population whose customs and prejudices were so opposed to everything foreign . . . ."<sup>17</sup>

Hunter's statement ignored the harsh nature of Chinese justice which was applied to foreigners during the period of the old China trade. The Chinese claimed jurisdiction over persons committing crimes on their soil regardless of nationality. On occasion the foreigners were denied the right of self defense when attacked and held responsible for injuries suffered by Chinese in such cases. Had the Chinese applied their law evenly and consistently, the foreigners might have found it more bearable, but the practice was to ignore one violation while insisting on full punishment for another. Two cases of accidental death show how unyielding Chinese justice could be. In 1784, a British seaman was strangled by the Chinese authorities for inadvertently causing the death of a native, and in 1821, an American seaman met the same fate for the same reason.<sup>18</sup>

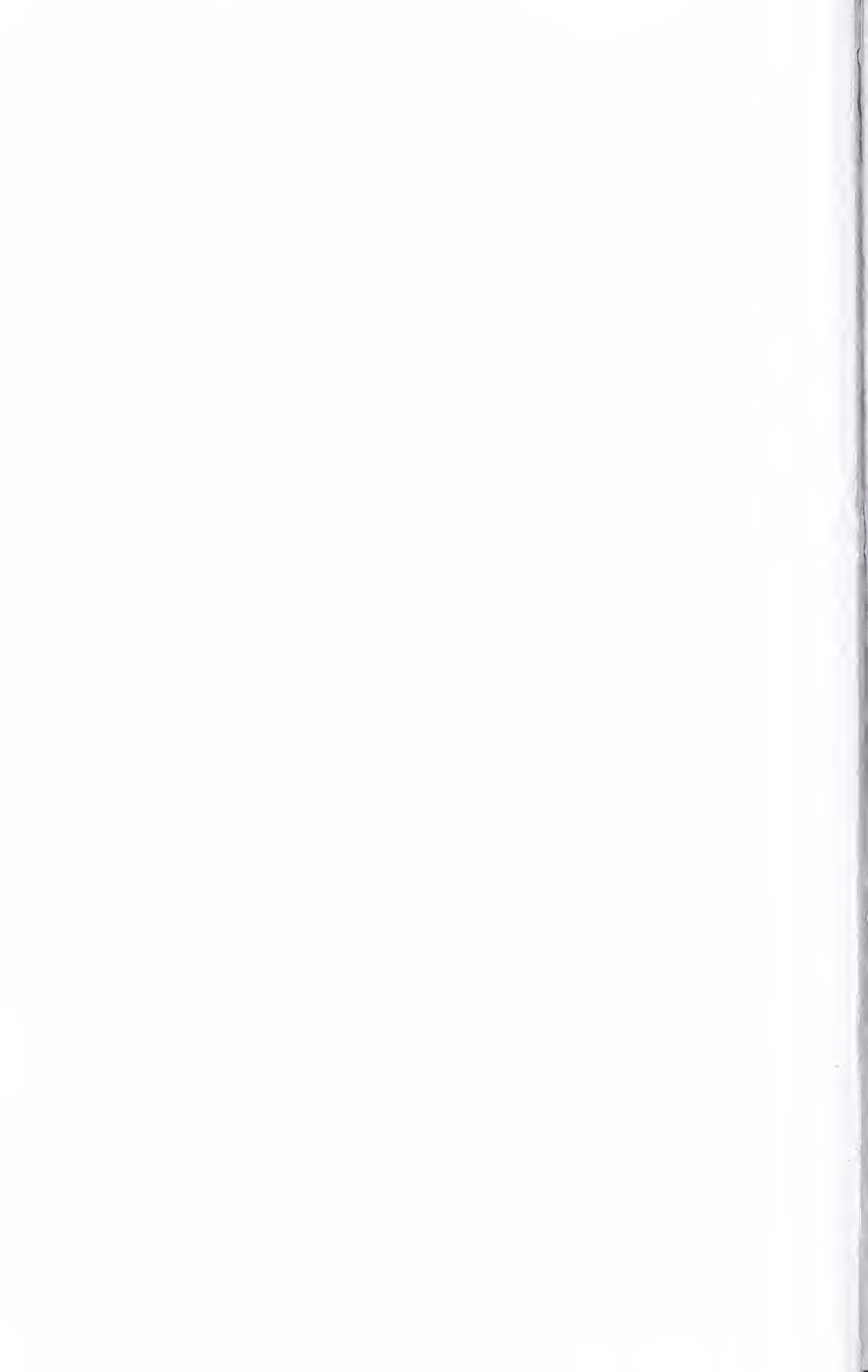
The inequities of Chinese jurisprudence were only one of several problems eroding the structure of the old China trade. The collapse of the Canton system stemmed primarily from China's refusal to compromise with the West on the matter of relations between sovereign states. China's concept of international relations focused on herself as possessor of a superior civilization surrounded by tribute-bearing subordinates. This view, applied for centuries to her Asian neighbors, was also considered applicable to the nations of the West. The Chinese attitude was tolerated for many years in the interest of trade, but its apparent permanence created increasing friction in Sino-Western relations. The accumulated discontents came to a head in 1834 when the British government revoked the East India Company's charter and replaced its agent in Canton with a regular diplomatic official. Controversy naturally followed because the old system contained no provision for normal diplomatic relations.

While the deepest source of irritation between China and the West lay in the distorted relationship between them, the conflict which ended the old China trade stemmed from the opium question. Traffic in the drug grew rapidly in the nineteenth century as the Western nations found opium a solution to their unfavorable balance of trade. By the 1830's, the opium trade formed a considerable part of the West's exports to China, although the Chinese had banned the drug entirely because of its

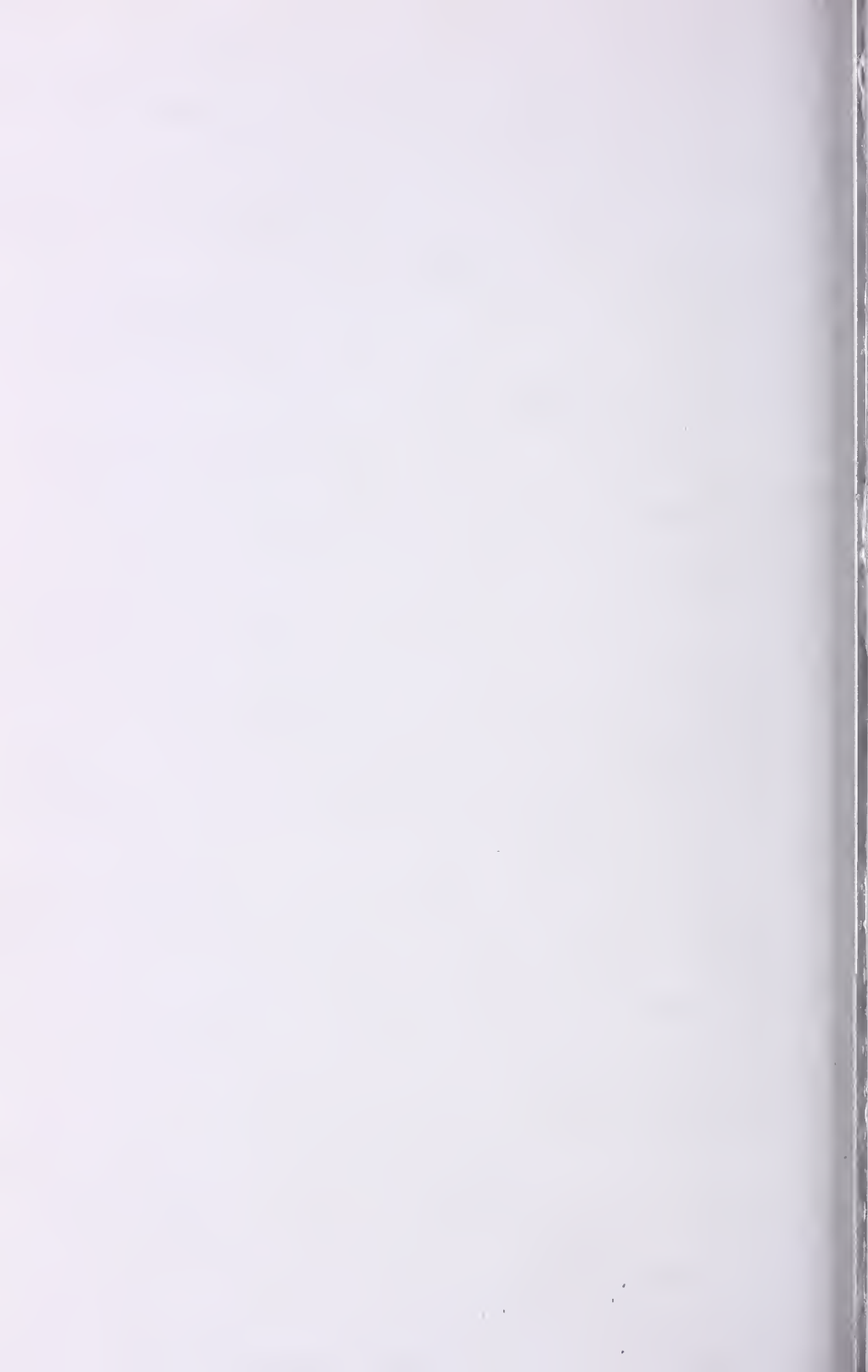
debilitating effects and the drain of silver used in its purchase. China's decision in 1839 to enforce her prohibition on opium combined with the other sources of Western unhappiness to make war inevitable. The struggle between England and China which followed ended the Canton system and altered China's relations with the West. The Treaty of Nanking, signed in August, 1842, opened new ports to trade, eliminated the co-hong, and introduced Western-style diplomatic relations. The old China trade was no more.

FOOTNOTES

- <sup>1</sup>The Chinese Repository, VII, 311.
- <sup>2</sup>William C. Hunter, *The Fan Kwae at Canton before Treaty Days, 1825-1844* (London, 1882), p. 1.
- <sup>3</sup>William C. Hunter, *Bits of Old China* (London, 1885), pp. 12-13.
- <sup>4</sup>The Chinese Repository, IV, 102.
- <sup>5</sup>William James Tyrone Power, *Recollections of a Three Years Residence in China* (London, 1853), pp. 232-233; *The Chinese Repository*, IV, 44-45.
- <sup>6</sup>*Ibid.*, 45.
- <sup>7</sup>*Ibid.*, 102.
- <sup>8</sup>Eldon Griffin, *Clippers and Consuls; American Consular and Commercial Relations with Eastern Asia, 1845-1860* (Ann Arbor, 1938), p. 242.
- <sup>9</sup>John Murray Forbes, *Letters and Recollections*, ed. Sarah Forbes Hughes (Boston and New York, 1899), I, p. 86.
- <sup>10</sup>Kuang Yung Pao, *The Compradore: His position in the Foreign Trade of China*, *The Economic Journal*, XXI (December, 1911), 636-641; Griffin, *Clippers and Consuls*, pp. 249-250.
- <sup>11</sup>Kenneth Scott Latourette, *The History of Early Relations between the United States and China, 1784-1844* (New Haven, 1917), pp. 22-23.
- <sup>12</sup>*Letters and Recollections*, I, p. 69.
- <sup>13</sup>Hosea B. Morse, *The International Relations of the Chinese Empire* (London, 1910), I, p. 70.
- <sup>14</sup>*Bits of Old China*, p. 15.
- <sup>15</sup>*The Chinese Repository*, IV, 45.
- <sup>16</sup>*Letters and Recollections*, I, p. 72.
- <sup>17</sup>*The Fan Kwae at Canton*, p. 16.
- <sup>18</sup>Morse, *The International Relations of the Chinese Empire*, I, pp. 102-103, 104-105; Foster Rhea Dulles, *The Old China Trade* (Boston and New York, 1930), pp. 134-135; *The Chinese Repository*, II, 423.







THE JOURNAL  
OF THE  
ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA 36830

VOLUME 41

JULY, 1970  
AUG 18 1972

NUMBER 3

THE AMERICAN MUSEUM



Officers of The Alabama Academy of Science  
1970-71

	Tenure	Term Begins	Term Expires
PRESIDENT..... W. L. Furman,	1 year	1970	1971
PRESIDENT-ELECT.....G. O. Spencer,	1 year	1970	1971
SECRETARY.....Tom Denton,	1 year	1970	1971
TREASURER..... William F. Arendale,	3 years	1969	1972
EDITOR OF JOURNAL.....Raymond Askew,	3 years	1969	1972
COUNSELOR OF THE AAAS....Roman Skorski,	Unexp.	1970	1971
PERMANENT COUNSELOR OF JUNIOR ACADEMY...Joseph C. Thomas,	3 years	1968	1971
ASSOCIATE COUNSELORS OF JUNIOR ACADEMY....John W. Holland,	3 years	1969	1972
R. P. Bauman,	3 years	1970	1973
COORDINATOR OF SCIENCE FAIRS..... G. O. Twellmeyer,	3 years	1968	1971
SECTION I--BIOLOGICAL SCIENCES			
Vice-President .....			Reuben Boozer
Vice-Chairman .....			Hugh Cunningham
SECTION II--CHEMISTRY			
Vice-President.....			David Zatko
Vice-Chairman.....			Carlton D. Whitt
SECTION III--GEOLOGY			
Vice-President.....			James A. Drahovzal
Vice-Chairman.....			Michael W. Szabo
SECTION IV--FORESTRY, GEOGRAPHY AND CONSERVATION			
Vice-President.....			M. K. Causey
Vice-Chairman .....			Merle Sherman
SECTION V--PHYSICS AND MATHEMATICS			
Vice-President.....			H. J. Foster
Vice-Chairman.....			Bernis Hannah
SECTION VI--INDUSTRY AND ECONOMICS			
Vice-President.....			G. T. Stewart
Vice-Chairman .....			Joseph Mason
SECTION VII--SCIENCE EDUCATION			
Vice-President.....			Elizabeth Martin
Vice-Chairman .....			Mary Carlson
SECTION VIII--SOCIAL SCIENCES			
Vice-President .....			Frank L. Owsley, Jr.
Vice-Chairman .....			Frances Roberts
SECTION IX--MEDICAL SCIENCES			
Vice-President .....			Leo M. Hall
Vice-Chairman .....			Charles P. Dagg
SECTION X--ENGINEERING			
Vice-President .....			C. K. Liu
Vice-Chairman .....			B. G. McKinney
SECTION XI--ANTHROPOLOGY			
Vice-President.....			Sarah A. Glass
Vice-Chairman.....			Karen R. Joines
BOARD OF TRUSTEES			
J. F. Volker, 1968-'71			Walter Bouldin, 1969-'72
Harry Philpott, 1968-'71			Walter B. Jones, 1969-'72
Frank A. Rose, 1968-'71			Lister Hill, 1969-'72
James Sulzby, 1969-'71			William J. Barrett, 1970-'73
James Fagan, 1969-'71			Howard E. Carr, 1970-'73
Howard Milling, 1970-'71			Emmett Carmichael, 1970-'73
			E. V. Smith, 1970-'73

**THE JOURNAL**  
**OF THE**  
**ALABAMA ACADEMY**  
**OF SCIENCE**

**AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE**

**VOLUME 41**

**JULY, 1970**

**NUMBER 3**

**EDITOR, PRO TEM.**

**Robert T. Gudauskas**  
**Auburn University**

**ARCHIVIST**

**Clyde H. Cantrell**  
**Auburn University**

**E D I T O R I A L   B O A R D**

**Lowell Wilson, Chairman**  
**Auburn University**

**Dan C. Holliman**  
**Birmingham-Southern**  
**College**

**Ann Everett**  
**Crossville High**  
**School**

*E. L. McGraw, Auburn University, Editorial Consultant*

---

**The Journal of The Alabama Academy of Science is published four times  
a year and is sent without charge to all members of the Academy.**

**The Journal is indexed in Biological Abstracts, Chemical Abstracts,  
America: History and Life, and Historical Abstracts.**

## CONTENTS

### ABSTRACTS

Biological Sciences . . . . .	117
Chemistry . . . . .	136
Geology . . . . .	140
Forestry, Geography, and Conservation . . . . .	148
Physics and Mathematics . . . . .	155
Industry and Economics . . . . .	164
Science Education . . . . .	165
Social Sciences . . . . .	168
Medical Sciences . . . . .	175
Engineering . . . . .	197
Anthropology . . . . .	203

### ARTICLES

Multiparameter Optimization Applied to Spectral Data Thomas R. Edwards . . . . .	210
Automated Treatment of Critically Ill Patients Following Operation L. C. Sheppard, N. T. Kouchoukos, J. C. Acton, and J. W. Kirklin . . . . .	216

ANNUAL BUSINESS MEETING MINUTES . . . . .	218
---	-----

## Abstracts

### ABSTRACTS

Papers presented at 47th Annual Meeting  
Auburn University, Auburn  
April 9-11, 1970

#### BIOLOGICAL SCIENCES

##### Daily Movement and Flight Behavior of Some Hérons, Ibises, and Egrets

Darrel Bateman and J. L. Dusi  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

A study of movement and behavior of the Cattle Egret, White Ibis, and Little Blue Heron was conducted using radio-telemetric methods. Study areas were located in extreme southeast Alabama and in north Jackson county, Florida. Existing radio-telemetric technique was adapted to studies of wading birds. Patterns of movement of breeding and non-breeding birds were established, distances to feeding locations were determined, and total daily flight distances were calculated. It was observed that the feeding areas of two nearby heronries overlapped.

##### Polyphenol Oxidase Activity of Corn Leaves Infected with Maize Dwarf Mosaic Virus

S. P. Beniwal and Robert T. Gudauskas  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Polyphenol oxidase activity of extracts from inoculated and subsequently emerging leaves of seedling corn, *Zea mays* L. 'HY x C103', was measured spectrophotometrically at intervals for 6 days after inoculation of plants with maize dwarf mosaic virus (MDMV). Inoculations were made by the carborundum-gauze pad technique with MDMV in sap from infected corn leaves. Control plants were inoculated with sap from healthy leaves.

No difference in polyphenol oxidase activity of MDMV-inoculated and control leaves was found at 0 and 24 hr after inoculation. Three days after inoculation, enzyme activity in MDMV-inoculated leaves was slightly higher (5%) than that of control leaves. A 20% increase in activity was measured in the first systemically-infected leaf (immediately above inoculated) 2 days after inoculation. By the fourth day, polyphenol oxidase activity in this leaf was only 11% higher than the control, and declined to a level equal to that of the control by 6 days post-inoculation.

##### Population Studies of Azygiidae (Trematoda) in *Percina nigrofasciata*

Martha Bradley  
Samford University, Birmingham, Alabama

*Percina nigrofasciata* is reported as host for *Leuceruthrus micopteri*,

*Proterometra* sp. and *Azygia longa* of the Trematode family Azygiidae. The specimens were obtained from the digestive tract of fish collected from six sites in the Cahaba River drainage system.

The Intestinal Helminth Fauna of *Etheostoma stigmaeum*  
and *Etheostoma whipplei* in the Cahaba River

Mary Leslie Burns  
Samford University  
Birmingham, Alabama

From 117 fish autopsied, 8 genera of helminths were found. The percentage of total infection was greater for *Etheostoma whipplei* being 78.5% as compared to 52.2% for *E. stigmaeum*.

The Cestoidea infection of infected fish was found to be greater in *E. whipplei* being 1.8%. The infecting cestode was *Bothriocephalus* sp. The Trematode infection of infected fish was greater in *E. whipplei* being 42.8% as compared to 24% for *E. stigmaeum*. The infecting trematodes were *Crepidostomum cooperi*, *Phyllodistomum etheostomae*, *Allocreadium* sp., and *Leuceruthrus micropteri*?. The Acanthocephalan infection of infected fish was greater in *E. stigmaeum* being 51.8% as compared to 40.8% for *Etheostom whipplei*. The infecting Acanthocephalan was *Acanthocephalus* sp. The Nematode infection of infected fish was greater in *E. stigmaeum* being 22.2% as compared to 0% for *E. whipplei*. The infecting nematodes were *Pilometra* sp. and *Spinintectus* sp.

The infection among the males was greater for both species of fish.

Influence of Light and Starch Reserves on Infection of  
Peanut Leaves by Conidia of *Cercospora arachidicola*

E. M. Clark, J. A. Lyle, and F. J. Subirats  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Peanut plants (*Arachis hypogaea*) inoculated with conidia of *Cercospora arachidicola* failed to become infected in the absence of light but infection was established under a normal diurnal cycle. Since light was necessary for infection, the susceptibility of leaves with depleted starch reserves (as tested by the I-KI starch test) could not be determined by using darkness to produce and maintain a starch-free condition. That was accomplished in shaded, greenhouse light by enclosing a plant and a container of 25% KOH solution under a plastic bag. KOH absorbed CO<sub>2</sub> from the air and within 24 hr the leaves gave a negative starch test. Starch-free plants were inoculated without admitting atmospheric CO<sub>2</sub> and the condition was maintained through a 72 hr incubation period. Incidence of infection on plants maintained in a starch-free condition for the infection period was about the same as that on plants with normal starch reserves.

## Abstracts

### Effect of Reserpine and Alpha-methyltyrosine On the Release of ACTH Secretion in the White Rat

Betty Cook and Kenneth Ottis  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

The objective of this study was to investigate the relationship between norepinephrine and the secretion of the adrenocorticotrophic hormone (ACTH). In order to determine whether a relationship existed, the norepinephrine concentration of the brain was decreased by the use of two pharmacological tools. Reserpine (200 ug/100 gram body weight) was used to deplete the norepinephrine stored in the nerve terminals, whereas, alphanethyltyrosine (5 mg/100 gram body weight) was used to block synthesis of norepinephrine.

Activation of the pituitary-adrenal axis was accomplished by stress in which rats were restrained for 30 minutes. The level of ACTH secretion was measured by the ascorbic acid depletion of the adrenal glands.

No significant differences were found between saline controls and the drug-treated animals. Therefore under these experimental conditions, it was apparent that norepinephrine was not the transmitter substance which initiated the secretion of ACTH.

### Relationship of Soil Fertility to Nematode Populations and Enzyme Activity

R. J. Collins, R. Rodriguez-Kabana, and E. M. Evans  
Departments of Botany and Plant Pathology, and Agronomy and Soils  
Auburn University, Auburn, Alabama

The influence of fertilizer treatments on populations of free-living and plant-parasitic nematodes and enzyme activity was studied in a post harvest soil sampling of field plots planted to corn. Fertilizer combinations ranged from a complete complement (N,P,K, plus minor elements) to treatments deficient in one or more components. Each plot had received the same treatment continuously for ten years, and all had been subjected to essentially the same rotation system. Numbers of free-living nematodes in the soil were generally related to yield of corn; highest numbers of free-living nematodes and highest yields occurred in limed plots that had received N,P,K, and a winter legume in rotation. Species of *Mononchus*, and *Dorylaimus* were particularly sensitive to the absence of any of the four major nutrients tested; these nematodes were present in significant numbers only in limed plots that had received N,P,K. Among the plant-parasitic forms, a similar distribution was found for the spiral nematodes, *Xiphinema* sp. and *Meloidogyne* sp. Lesion nematodes (*Pratylenchus* sp.) occurred in highest numbers in plots that had received incomplete fertilization and no winter legume in rotation. Plots with complete fertilizer combinations had the lowest numbers of lesion nematodes. Significant numbers of stubby root nematodes (*Trichodorus* sp.) were present in only one plot which had received N,P,K, but no lime or trace elements.



Activity of dehydrogenases and catalase in the soil was related to yield of corn; highest activity and greatest yield occurred in limed plots that had received complete fertilizer combinations. Correlations between enzymatic activity and yields or enzymatic activity and numbers of nematodes which were related to yield were not precisely defined.

Effect of Atrazine on the Senescence of  
Corn Leaf Discs

Leonard G. Copping and D. E. Davis  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Corn leaf discs were incubated in both light and darkness for 4 days in solutions containing kinetin and atrazine both separately and in combination. Chlorophyll content was assayed spectrophotometrically with 80% acetone disc extracts. Absorption data at 660 m $\mu$  and 645 m $\mu$  were used to develop simultaneous equations which gave the chlorophyll a and b content of the discs.

Control discs in water showed a marked loss of chlorophyll. Atrazine and kinetin both individually delayed the loss of chlorophyll from discs. Atrazine is, therefore, showing a similar effect to that of kinetin. When both chemicals were applied together the results were similar to those found for kinetin alone. The atrazine effect was optimal at a concentration of  $5 \times 10^{-8}M$ , and was less marked in tissue maintained in diffuse light than in tissue maintained in darkness.

Effect of Herbicides on Sclerotial Production by  
*Sclerotium rolfsii* and *Sclerotinia trifoliorum* in Soil

E. A. Curl and H. Wayne Beam  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Effects of five organic herbicides in soil on sclerotial production by two soil-borne plant-pathogenic fungi, *Sclerotium rolfsii* and *Sclerotinia trifoliorum*, were investigated *in vitro*. The herbicides (technical grade) were: diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea], paraquat (1,1'-dimethyl-4,4'-bipyridinium salt), prometryne [2,4-bis(isopropylamino)-6-methylmercapto-s-triazine], EPTC (ethyl N,N-dipropylthiolcarbamate), and cotolan [3-(M-trifluoromethylphenyl)-1,1-dimethylurea]. Flasks of sandy loam soil supplemented with 1% cornmeal were autoclaved and inoculated with chopped mycelial suspensions of the two fungi separately. After 48 hr, alcoholic stock solutions of herbicides were applied to provide concentrations of 0 (alcohol control), 2.5, 5, 10, and 20  $\mu g/g$  of soil. Cultures of *S. rolfsii* were incubated at 28 C for 26 days and *S. trifoliorum* at 25 C for 29 days. Sclerotia were recovered by washing and screening and both total numbers and dry weights determined.

None of the compounds significantly stimulated sclerotial production. Numbers of sclerotia of *S. rolfsii* in soil with 10 and 20  $\mu g$  diuron, EPTC,

or cotoran were greatly reduced, whereas paraquat and prometryne had little effect. Similar effects were recorded for *S. trifoliorum*, except that diuron and EPTC significantly inhibited sclerotial production at all concentrations (2.5-20 µg/g). The inhibitory effect usually increased with the increase in herbicide concentration.

## Influence of Fertility and Biotic Soil Factors on the Activity of Plant-Pathogenic Fungi

E. A. Curl and R. Rodriguez-Kabana  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Effects of biotic factors on three root-disease fungi, *Sclerotium rolfsii*, *Rhizoctonia solani*, and *Fusarium oxysporum* f. sp. *vasinfectum*, were studied in 10 field plots for a period of 3 years. The plots, on the Auburn University Agronomy Farm, had received continuous differential fertilization for 10 years with treatments ranging from a full fertilizer complement to treatments deficient in one or more components.

Microbial populations and soil enzyme activity were generally highest in plots that supported best plant growth and yields. Germination of sclerotia of *S. rolfsii* on the various plot soils was not affected by fertilizer treatment, but new sclerotial production was enhanced in soil that had received no lime (low pH). All plot soils suppressed germination of chlamydospores of *F. vasinfectum*, the effect varying considerably among plots and between spring and fall seasons. *Rhizoctonia* infestation, as determined by organic matter colonization in plot soils, was low in nutrient-deficient plots and highest in a complete fertilizer treatment. The percentage of natural organic particles (screened from soil) that were colonized by organisms inhibitory to the three pathogens varied greatly among plots. Antibiosis was caused primarily by bacteria and the fungal saprophyte, *Trichoderma viride*. Further investigation will be made to relate these biotic factors to seedling diseases of cotton and soybean.

## Orchids of Alabama

Blanche Dean  
Goodwater, Alabama

One hundred years ago, more or less, the flora of Alabama was unsurpassed by the surrounding states except North Carolina for reasons not to be considered here. What changes have the inroads of progress and civilization done for one species? Consider the native orchids for example. Dr. Charles Mohr in his *Plant Life of Alabama* in the 1890's listed 37 species which he had found. His work did not cover thoroughly every county. In 1920, Graves reported (*Fern Journal* 10:3) 40 species without listing them. My records list only 30. Much more field work needs to be done before the question is solved. Listed below are the orchids found to date. The asterisk indicates orchids on Dr. Mohr's list which I have not found. *Cypripedium acaule* Ait., *C. calceolus* (Willd.)

Correll, \**C. parviflorum* (Salib.) Fern., *Orchis spectabilis* L. *Habenaria lacera* (Michx.) Lodd., *H. peramoena* Gray, \**H. repens* Nutt., *H. integra* (Nutt.) Spreng, *H. nivea* (Nutt.) Spreng, \**H. holopetala* (Lindel.) Gray, *H. flava* (L.) R. Br., *H. clavellata* (Michx.) Spreng, *H. blephariglottis* (Willd.) Hook, *H. ciliaris* (L.) R. Br., *H. cristata* (Michx.) R. Br., \**H. quinqueseta* (Michx.) Eat., *Listera australis* Lindel., *Triphora trianthophora* (SW.) Rydb., *Cleisthes divaricata* (L.) Ames, *Isotria verticillata* (Muhl. ex Willd.) Raf., *Pogonia ophioglossoides* (L.) Ker.-Gawl., *Calopogon pulchellus* (Salisb.) R. Br., *C. pallidus* Chapm., \**C. barbatus* (Walt.) Ames, \**Ponthieva racemosa* (Walt.) C. Mohr., *Tipularia discolor* (Pursh) Nutt., \**Epidendrum conopseum* R. Br., *Aplectrum hyemale* (Muhl. ex Willd.) Torr., *Hexalectris spicata* (Walt.) Barnh., *Corallorhiza odontorhiza* (Willd.) Nutt., *C. wisteriana* Conrad, *Goodyera pubescens* (Willd.) R. Br., *Malaxis unifolia* Michx., *Liparis lilifolia* (L.) L. C. Rich, \**L. loeselii* (L.) L. C. Rich, *Spiranthes cernua* (L.) L. C. Rich, *S. gracilis* (Bigel.) Beck., *S. floridana* (Wherry) Correll, *S. praecox* (Walt.) S. Wats., \**S. vernalis* Engel. & Gray, and *S. odorata* (Nutt.) Correll.

Bacterial Analysis of Swan Creek,  
Limestone County, Alabama

Peter DeAugustine  
Department of Biology  
Athens College, Athens, Alabama

Water quality in Swan Creek was determined in terms of dissolved oxygen and bacterial population count. Membrane filter technique, multiple tube dilution technique, and polarograph analysis were used. Water samples were collected at various points north and south of the Athens Sewage Treatment Plant, Athens, Alabama. Samples collected north of the treatment plant indicated polluted areas were insignificant relative to points south of the plant. There was a decrease of 60% dissolved oxygen content below the plant compared to 5 miles north of the plant. *Coliform* sp. counts at all points below the plant were too numerous to count. Further evidence of contamination was indicated by the presence of certain organisms which thrive under relatively anaerobic conditions. These organisms were identified as the bacteria, *Sphaerotilus natans*, and the invertebrate, *Tubifex tubifex*. The results indicated that the creek was heavily polluted and unsafe for public use. The analysis was conducted in conjunction with the State Board of Health Laboratories, Decatur, Alabama.

Somatic Chromosomes of the Southern Brook Lamprey, *Ichthyomyzon gagei*

Charles Duckett  
Department of Biology  
Samford University, Birmingham, Alabama

The primitive character of modern Agnathans has prompted a number of chromosome studies on these forms within the past decade. Within this time, chromosome numbers of seven species of lampreys belonging to three genera have been determined with diploid counts ranging from 60-

164. This current investigation was undertaken to determine whether a difference in chromosome number and morphology exists between the only reported North American species, *Lampetra aepyptera*, the Ohio Brook Lamprey and the Southern Brook Lamprey, *Ichthyomyzon gagei*. Eight ammocoetes of *Ichthyomyzon gagei* were collected from the Cahaba River system and slides were made and scanned for metaphase chromosomes. Six suitable spreads revealed that the diploid chromosome number of *Ichthyomyzon gagei* was 164, the same number as was reported for *Lampetra aepyptera*. No morphological difference could be detected between the chromosomes of the two species.

Although little correlation seems to exist between the chromosome counts and morphology of the seven previously reported species, there appears to be a great similarity existing between the chromosomes of these two North American lampreys.

#### Vocalizations of Some Wading Birds

Julian L. Dusi  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

While wading birds are not songbirds, their vocalizations are an important part of their behavior. Some of the vocalizations of Cattle Egrets, White Ibises, and Purple Gallinules are given, as well as the general sounds of a nesting colony.

The Cattle Egret has several distinct notes. A clucking, which sounds very much like a chicken, is an alarm note; an aggressive screaming note, which is used in repelling other birds; and the aggressive notes of young birds, held in the hand, are given. The adult White Ibis gives a low honking note. The young give rapidly repeated high notes. The Gallinule gives a long cackling series of notes, as an aggressive vocalization and single repeated call notes as alarm notes.

#### Peroxidase Activity of Subcellular Fractions Isolated from Bean Hypocotyls of Differing Age

A. C. Edwards and B. Truelove  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Peroxidase activities associated with various subcellular fractions isolated from *Phaseolus vulgaris* hypocotyl tissue grown in the dark were determined. Plants were harvested at 2-day intervals from day 3 to day 13. One-inch portions of the hypocotyls, measured from the cotyledonary nodes, were ground in a buffered sucrose solution and the cell debris was separated by filtration. The filtrate was separated by differential centrifugation into the fractions sedimented at: (1) 3,000 *xg*, (2) 10,000 *xg*, (3) 150,000 *xg* and the remaining supernatant. Each particulate fraction was washed and each fraction was assayed for peroxidase activity spectrophotometrically using  $H_2O_2$  as substrate and *o*-dianisidine as

electron donor. Total protein in each fraction was determined using the Lowry method and peroxidase activity expressed per mg protein. Total tissue homogenate activity increased with time. The isolated fractions showed varying increases in activity; the greatest increases occurred in fractions 1 and 3, while smaller increases were observed in fraction 2, the cell debris and supernatant.

Effect of 2,4-D on Water Relations  
of Cotton and Corn Seedlings

M. Juanita Galloway and D. E. Davis  
Auburn University, Auburn, Alabama

Corn (*Zea mays* L., 'Dixie 18') and cotton (*Gossypium hirsutum* L., 'DPL 40') seed were planted in vermiculite and germinated in a light and temperature controlled growth chamber. Six days after planting, the seedlings were transferred to plastic cups containing aerated Hoagland and Arnon's No. 2 nutrient solution. After 24 hr, seedlings were selected for maximum uniformity and transferred to fresh aerated nutrient solutions containing 0,  $10^{-10}$ ,  $10^{-9}$ ,  $10^{-8}$ ,  $10^{-7}$ ,  $10^{-6}$ ,  $10^{-5}$ ,  $10^{-4}$ , and  $10^{-3}$ M 2,4-dichlorophenoxy-acetic acid (2,4-D). There were five replications for each concentration. At time of transfer and after 24 and 48 hr, each plant and its container were weighed. After 48 hr, plants were removed from solution and fresh weights determined. Results showed that both transpiration and fresh weight of cotton were increased at the lower concentrations of 2,4-D application and decreased at the higher concentrations. The stimulatory effect was not observed in corn but strong inhibition occurred at the higher concentrations.

A Pilot Study of the Ecology of a Plot of the Giant  
Bamboo (*Phyllostachys* sp.) in Prattville, Alabama

John R. Hopkins  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

Phase I of this research was conducted June 28, 29, and July 5. Phase II was conducted July 6, 12, 13, and 20, 1969. In Phase I, three areas representing the bamboo community, an oak-hickory community adjacent to the bamboo, and a nearby control area devoid of vegetation were recognized for determination of the following edaphic factors: (1) light intensity, (2) maximum-minimum temperature, (3) relative humidity and (4) relative rate of transpiration between black and white atmometer bulbs. Only light intensity was found to be a significant variable factor and was, therefore, researched more intensively in Phase II. Phase II consisted of a 675 ft base line marked at 25 ft intervals with a line perpendicular to it extended 5 feet on either side, thus establishing a belt transect 675 x 10 ft long. The transect was further subdivided into 27 25 x 10 ft quadrats to facilitate data collection. Data obtained from the transect consisted of (1) relative light intensity along the line at 25 ft intervals, (2) an estimated percent total cover of groundstory, understory and overstory, and (3) species



in order of importance or of ecological significance in the above mentioned strata.

An area of 125 ft along the transect which bisected the bamboo community was found to be devoid of groundstory and understory vegetation. Light intensity readings in this area were 0.1% full sunlight. Ground-story and understory vegetation was present along the remainder of the transect which consisted primarily of an oak-hickory type community. The species in overall order of importance in the groundstory were honeysuckle (*Lonicera japonica*) and *Smilax* sp.; species in overall order of importance in the understory were dogwood (*Cornus florida*) and hickory (*Carya* sp.).

#### Some Common Protozoa of Limestone County, Alabama

D. K. M. Hudson and A. W. Vaughn  
Department of Biology  
Athens College, Athens, Alabama

During early spring of 1970, 18 bodies of water throughout Limestone County, Alabama, were surveyed to determine which protozoa were present, their habitat preference, distribution and abundance. At each location samples were taken of the substrate, middle waters and surface. The locations chosen for sampling were grouped as: stagnant water, streams, ponds and water with much decaying vegetation.

Four protozoan genera were frequently found in the samples. These were *Chilomonas*, *Colpoda*, *Halteria* and *Monas*. Also, *Euglena*, *Oikomonas*, *Paramecium* and *Prorodon* were often found. In all, 32 genera were identified with flagellates and ciliates being by far the most common, having 15 and 14 genera respectively; while only 3 sarcodinid genera were found. Stagnant waters and waters with decaying vegetation had many more protozoa present than did the ponds or streams sampled. Most protozoans seemed to prefer either the substrate or the surface water, with the majority preferring the substrate.

#### The Ecology of the Ferns of Cypress Creek

Catherine Hunnicut and J. R. Bourne  
Florence State University  
Florence, Alabama

An investigation was initiated during the spring of 1970 to determine the fern flora of Cypress Creek and to further study ecological characteristics which would be measurable during a growing season. Cypress Creek originates in northwest Lauderdale County and empties into the Tennessee River west of Florence. Sizeable limestone formations border the lower portion of the stream and it was here that the survey was concentrated.

Representative specimens of the fern flora along the banks of Cypress Creek were collected from the termination of Cypress Creek upstream



to the first principal tributary. Ferns which could be seen from each bank of the stream were arbitrarily considered to be within the limits of this survey. Field information recorded at the time of collection included geological location, distance from stream, azimuth and associated plant species. A small portion of soil associated with the roots was included with the fern plant. The plant, soil and data card were transported to the ecology laboratory in sealed plastic bags. Numbers were assigned to each specimen and retained during laboratory measurements for identification purposes. Morphological and ecological parameters were taken and recorded. Data included determinations of collected fern specimens, soil texture, easily-oxidizable organic matter, pH, stem-root ratios and associated invertebrate animal fauna.

A total of 6 ferns species representing 1 family was found in the designated collecting area of Cypress Creek. Field determinations of soil texture revealed that loams predominated and these ranged from sandy to silt loams. The average organic matter content of all samples was 4.6%. pH of the ferns collected from limestone formations bordering the creek was consistently higher than that of the soil from ferns collected in sandy areas of the stream bank reflecting the alkaline conditions of the substratum in the limestone formations. The wide diversity of stem-root ratios was indicative of the morphological differences revealed in the limited number of fern specimens collected during the earliest portion of the growing season in this area. Invertebrate animals were abundant in the soil and organic material adhering to the roots of the fern. As would be suspected, the primitive insect, Order Collembola, predominated in number with at least three species of this Order present. A wide range of other invertebrates made up the rest of the animal fauna.

Additional collections will be made during the entire growing season and the survey will be extended to the origin of Cypress Creek.

#### Polarographic Determination of Glucose with Glucose Oxidase

Mongi Jemmali and R. Rodriguez-Kabana  
 Institut de la Recherche Agronomique, Paris, France  
 and Department of Botany and Plant Pathology  
 Auburn University, Auburn, Alabama

A rapid method for determination of glucose in aqueous solution was developed using a polarograph (Model 53, Biological Oxygen Monitor, Yellow Springs Instruments Co., Yellow Springs, Ohio) with a Clark-type  $O_2$  electrode. The method is based on the measurement of the rate of  $O_2$  removal ( $-dO_2$ ) during oxidation of glucose to gluconic acid with glucose oxidase.

$\frac{dO_2}{dt}$   
 Values for  $\frac{-dO_2}{dt}$  were approximated by determining the tangent of the angle formed by the recorded trace with the horizontal  $\left| \frac{-\Delta O_2}{\Delta t} \right|$ ; these values were

linearly related to glucose concentration,  $[G]$ , in the 5-800  $\mu\text{g/ml}$  range. With fixed  $[G]$ , tangent values increased proportionately with enzyme concentration in the 0-1.0  $\text{mg/ml}$  range. Tangent values increased rapidly during the first 10 hr after preparation of the electrode membrane; soaking

in water for 24 hr was necessary to attain consistency. Glycerol which was added to stabilize enzyme solutions and facilitate analysis of particulate samples depressed  $\left| \frac{-\Delta O_2}{\Delta t} \right|$ . At constant  $[G]$ , this depression was

linearly related to glycerol concentration. When amounts of glucose (S), enzyme (E), glycerol (Gy), and final volume in reaction chamber ( $V + \Delta V$ ) were simultaneously varied, values of  $\left| \frac{-\Delta O_2}{\Delta t} \right|$  were predictable according

to:  $\left| \frac{-\Delta O_2}{\Delta t} \right| = k \frac{(S)(E)}{(V + V)(Gy)} - b$ . The method was compared with conventional chemical and spectrophotometric-enzymatic procedures in the analysis of colored premelanoidin solutions. Statistical analysis indicated that using 3 replicates differences of 1  $\mu\text{g/ml}$  glucose could be detected between samples in the 0-80  $\mu\text{g/ml}$  range. Samples with higher glucose concentrations required considerably larger number of replicates.

# A Survey of the Algae of Calhoun County, Alabama

Kenneth Landers and Thomas Cochis  
Jacksonville State University  
Jacksonville, Alabama

*Chlamydomonas*, *Chlorella*, *Oedogonium*, *Protococcus*, *Spirogyra*, *Ulothrix*, and *Zygnema* are common green algae in a number of areas of Calhoun County. *Draparnaldia* is abundant on rocks in swift streams in early spring. *Haematococcus* grows in depressions of limestone rocks and in various man-made structures. *Volvox* and *Hydrodictyon* were collected from a pond at the Eastaboga State Fish Hatchery. *Chara* grows abundantly in the overflow stream at Germania Springs, a source of water for the city of Jacksonville. Specimens of *Chara* with numerous oogonia (nucules) and antheridia (globules) were collected in the summer of 1969. Other green algae collected from the cool, clear water of Cane Creek near Willet Springs were *Pandorina*, *Microspora*, *Cladophora*, *Pediastrum*, *Coccolobastrum*, *Ankistrodesmus*, *Scenedesmus*, and *Mougeotia*. The desmids *Closterium*, *Cosmarium*, *Desmidium*, *Hyalotheca*, *Micrasterias*, *Staurastrum*, and *Xanthidium* grow in springs, creeks, and lakes. *Elakatothrix* and *Zygnemopsis* were collected on one occasion in the Spring of 1967.

The unicellular flagellate *Euglena* causes reddish-green blooms on farm ponds and ponds at the Eastaboga State Fish Hatchery. The dinoflagellate *Ceratium* is abundant in the waters of Nesbit's Lake along with the golden brown algae *Dinobryon* and *Synura*. *Tribonema* and *Vaucheria* grow in cool creek waters. *Vaucheria* also grows in springs, roadside ditches, and on moist soil. *Vaucheria geminata* (Vauch.) De Cand. was collected in Cane Creek near Willet Springs during the summer of 1969. Diatoms collected at various locations include *Meridion*, *Diatoma*, *Navicula*, *Gomphonema*, *Cymbella*, *Nitzschia*, and *Surirella*.

*Anabaena*, *Nostoc*, and *Oscillatoria* are common blue green algae on the soil and in the water. *Aphanotheca*, *Gloeocapsa*, *Merismopedia*, *Microcystis*, *Lyngbya*, *Microcoleus*, *Spirulina*, *Seytonema*, and *Rivularia* are among the other blue green algae of the county.

*Batrachospermum* is abundant in a number of small streams in early spring. This fresh water red alga can also be collected in cool springs throughout the summer.

Summer Flowers of Northeast Alabama

Kenneth Landers, Jerry Clonts, Thomas Cochis, and J. Leonard Henry  
Jacksonville State University  
Jacksonville, Alabama

Indian hemp (*Apocynum cannabinum* L.), butterfly-weed (*Asclepias tuberosa* L.), white-topped aster (*Aster solidagineus* Michaux), trumpet vine (*Campsis radicans* (L.) Seemann), and maypops (*Passiflora incarnata* L.) are common summer flowering herbs and vines along the fence rows, roadsides, and woodland margins of northeast Alabama. Summer flowering herbs of pastures, roadsides, and waste places include dog fennel (*Anthemis cotula* L.), ox-eye daisy (*Chrysanthemum leucanthemum* L.), Queen Anne's lace (*Daucus carota* L.), bitter-weed (*Helenium amarum* (Raf.) H. Rock), white sweet clover (*Melilotus alba* Desr.), yellow sweet clover (*Melilotus officinalis* (L.) Lam.) and woolly mullein (*Verbascum thapsus* L.). Sourwood (*Oxydendrum arboreum* (L.) DC.) is a conspicuous flowering tree throughout the area on well-drained sites. Virginia creeper (*Parthenocissus quinquefolia* (L.) Planchon) is a common vine in dry, rocky or moist rich woods. False aloe (*Agave virginica* L.), spotted wintergreen (*Chimaphila maculata* (L.) Pursh), rattlesnake master (*Eryngium yuccifolium* Michaux), wild quinine (*Parthenium integrifolium* L.) and mountain mint (*Pycnanthemum incanum* (L.) Michaux) grow in open to dense upland coniferous and hardwood forests. New Jersey tea (*Ceanothus americanus* L.) occurs frequently in mixed forest and open areas.

Flowering shrubs of moist rich woods include hercules club (*Aralia spinosa* L.), mountain hydrangea (*Hydrangea arborescens* L.), oak-leaf hydrangea (*Hydrangea quercifolia* Bartr.), and elderberry (*Sambucus canadensis* L.). Elderberry usually grows in more open, swampy habitats. Hercules club also grows on drier sites.

Flowering herbs, subshrubs, and vines of rich woods and stream banks include black snakeroot (*Cimicifuga racemosa* Nuttall), leather-flower (*Clematis viorna* L.), beetleweed (*Galax aphylla* L.), angle-pod (*Matelea gonocarpa* (Walter) Shinnars), partridge berry (*Mitchella repens* L.), starry campion (*Silene stellata* (L.) Aiton f.) and Indian pink (*Spigelia marilandica* L.). Bluebell (*Campanula americana* L.) also grows in rich deciduous woods but is more frequent in areas with circumneutral soils.

Lizard's tail (*Saururus cernuus* L.), water-willow (*Justicia ovata* (Walter) Lindau.), fragrant water-lily (*Nymphaea odorata* Aiton), water-cress (*Nasturtium officinale* R. Brown) and sacred lotus (*Nelumbo nucifera* Gaertner) occur in the ponds, lakes, and streams. Buttonbush (*Cephalanthus occidentalis* L.) is a common flowering shrub along the fish ponds, lakes, and stream banks. Ground-nut (*Apios americana* Medicus.), jewel-weed (*Impatiens capensis* Meerb.), joe-pye-weed (*Eupatorium fistulosum* Barratt), cardinal flower (*Lobelia cardinalis* L.), spearmint (*Mentha spicata* L.), climbing hempweed (*Mikania scandens* (L.) Willd.), bearsfoot

## Abstracts

(*Polymnia uvedalia* L.), and summer phlox (*Phlox paniculata* L.) grow in bottomland woods, marshes, wet meadows, and along streams. Summer flowering herbs of infrequently occurring pitcher-plant bogs (*Sarracenia flava* L.) include yellow fringed-orchid (*Habenaria ciliaris* (L.) R. Brown), marsh-pink (*Sabatia campanulata* (L.) Torrey), primrose-willow (*Ludwigia alternifolia* L.), and the meadow-beauties (*Rhexia mariana* L., and *Rhexia virginica* L.).

### Increased Disease Susceptibility Associated with Russetting in Golden Delicious Apples

A. J. Latham

Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

During the past two years, summer fruit-rotting in russeted Golden Delicious apples has been quite noticeable in the Piedmont Substation orchard near Camp Hill, Alabama. Fruit rotting has occurred, although trees were sprayed with proven recommended fungicides according to the latest approved practices. Apples from sprayed trees showed higher russet indices than fruit from unsprayed trees. Russetting was so severe on some apples that epidermal tissues cracked, apparently exposing parenchyma cells to invasion by air-borne fungus spores. The fungi and frequency of isolation from rotted apples was *Alternaria* sp. 73%, *Phytophthora obtusa* 1%, and unknown fungi 26%. Total summer rot incidence was 3.2% of harvested fruit. *Alternaria* spp. were most frequently associated with the disease; and, also predominated in weekly samplings of air-borne spores in the orchard. Temperature, humidity, and rainfall data collected in the orchard indicated that conditions presumably conducive for infection and disease development occurred throughout the period of fruit maturation.

### Effect of Some Systemic Pesticides on Infectivity of Maize Dwarf Mosaic Virus

Donald W. Lindsey, Robert T. Gudauskas, and S. P. Beniwal  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Dimethylsulfoxide (DMSO), benzimidazole (BZ), methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (Benlate), and 2,3-dihydro-5-carboxanilido-6-methyl 1-l,4 oxathiin-4,4-dioxide (Plantvax) have systemic fungicidal activity against some plant pathogenic fungi, including a few that are obligate parasites. Possible virucidal activity of the chemicals was evaluated with maize dwarf mosaic virus (MDMV), an important pest of corn in Alabama and other areas of the United States. Action of the chemicals on infectivity of the virus in virus-chemical mixtures and also in preventing or eradicating MDMV-infection in corn seedlings was determined.

MDMV diluted in aqueous solutions of 0.1-1% DMSO showed little loss in infectivity; however, infectivity was reduced by 75% when the virus was

suspended in 5% DMSO and by 90 and 100% in 20 and 50% DMSO, respectively. MDMV in solutions of 0.01-1% Benlate and 0.01-0.1% Plantvax was about as infectious as virus suspended in water only; infectivity was reduced 50% in 1% Plantvax and 96-100% in 5 and 10% solutions of either chemical. Benzimidazole in concentrations of 0.1 and 1% appeared to enhance infectivity. None of the chemicals applied as foliar sprays, soil drenches or seed treatments protected corn seedlings from subsequent infection by MDMV; foliar sprays did not suppress symptom development in previously infected seedlings.

Water Quality and Plant Nutrition Studies with  
Submerged Aquatic Weeds in Pickwick Reservoir

J. B. Martin, B. N. Bradford, and H. G. Kennedy  
Tennessee Valley Authority  
Muscle Shoals, Alabama

Water quality studies were conducted from July 1966 through December 1968 to investigate nutritional phenomena associated with excessive growth of *Najas*, a rooted, submerged aquatic weed that infested 14% of Pickwick Reservoir in 1965. Chemical analysis of the reservoir water showed no correlation between nutrients in the water and growth or nutrient content of plant material. Variations in nutrient concentrations of lakebed sediment could not account for the presence or absence of *Najas* in specific locations within the reservoir.

Greenhouse experiments showed that both lakebed sediment and reservoir water contributed factors necessary for the growth of *Najas*, but influence of sediment as a nutrient source was much more pronounced than the nutrient contribution of reservoir water. When lakebed sediment was diluted with nutrient-free sand to give sediment concentrations of 100, 50, 25, and 12.5%, yield of *Najas* and uptake of N, P, K, Ca, and Mg decreased linearly with decreasing amounts of sediment in the rooting medium. Thus, inorganic nutrient absorption occurred largely from lakebed sediment through the *Najas* root system.

A 7-fold dilution of reservoir water with demineralized water was required to reduce the growth of *Najas*. In order to identify the contributing factor to *Najas* nutrition, 10 water sources with varying nutritional characteristics were evaluated as nutrient sources. *Najas* growth was independent of the nitrogen and phosphorus contents of the water, but was positively correlated with base content and alkalinity largely as the  $\text{HCO}_3^-$  ion. Further investigations showed that the major contribution of reservoir water to the growth of *Najas* was to supply the  $\text{HCO}_3^-$  ion as a carbon source for photosynthesis.

Effect of Atrazine on Leucine Incorporation  
and Phosphate Uptake by Cotton Roots

James R. Owens and D. E. Davis  
Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

Effects of atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-



triazine) on amino acid absorption and incorporation into protein, and phosphate uptake, by excised cotton roots, were studied using  $^{14}\text{C}$  - labeled leucine and  $^{32}\text{P}$  - labeled phosphoric acid. Cotton roots incubated in a modified White's medium were treated either with atrazine +  $^{14}\text{C}$ -leucine for 12 and 24 hr or with atrazine + labeled phosphate for 18 hr. Low concentrations of atrazine ( $10^{-7}$ ,  $10^{-8}\text{M}$ ) stimulated leucine absorption by the roots and its incorporation into protein. Data obtained using a high atrazine concentration ( $10^{-4}\text{M}$ ) showed no significant difference from the control. Both atrazine concentrations tested ( $10^{-7}$  and  $10^{-4}\text{M}$ ) stimulated phosphate uptake.

## An Investigation of Crayfish from Selected Streams of the Tennessee River Valley for the Presence of Chlorinated Hydrocarbon Residues

John F. Phillips, John R. Bourne, Carl Lindsey, and W. J. Dickson  
Department of Science  
Florence State University, Florence, Alabama

Crayfish, (*Cambarus* sp.) from Coxes Creek, Little Cypress Creek, and Burcham Creek were qualitatively examined for the pesticide 1,1,1 - trichloro - 2,2 - bis (P-chlorophenyl) ethane (DDT). All three creeks are tributaries of the Tennessee River and all drain cotton farm land having an extensive history of DDT treatment.

The exoskeleton was removed from the specimen within 1 hr after collection from the stream, and the soft tissue stored in diethyl ether overnight. The ether and tissue were poured into the thimble of a soxhlet extractor and the tissue extracted with ether for 2 to 4 hr. Following extraction, the bulk of the ether was stripped under vacuum at room temperature and the remaining orange extract applied to a narrow strip near the bottom of an 18 cm X 18 cm silica gel thin layer plate. The silica gel, impregnated with a fluorescent dye, was supplied by the Alupharm Chemicals. The plates were activated by heating to  $110^\circ\text{C}$  before use. The chromatogram was developed for 90 minutes with a mixture of 5% benzene and 95% m-hexane. The band having the same retention value as authentic P, P' DDT ( $R_f \approx 0.5$ ) was carefully removed and the pesticide extracted from the silica gel with diethyl ether. The ether extract was spotted on a fresh plate together with authentic DDT and developed in 5% benzene, 95% hexane. DDT strongly absorbs light between 2,800 and 2,540 Å and thus appears as a black spot on the thin layer plate in short wave length ultra violet light. Spots having the same  $R_f$  as DDT were confirmed by comparing their ultraviolet spectra with authentic DDT.

DDT was found in all crayfish examined. Quantitative estimates of DDT by ultraviolet spectroscopy were not possible because an impurity absorbing at slightly longer wave length, 2,700 ~ 2,900 Å, had the same  $R_f$  value as DDT.



Histochemical Studies on a Species of *Pelodera*

R. Rodriguez-Kabana and E. Mora

Department of Botany and Plant Pathology, and Poultry Science  
Auburn University, Auburn, Alabama

Histochemical studies of fixed (paraformaldehyde) specimens of *Pelodera* (*Pelodera*) *chitwoodi* (Bassen, 1940) Dougherty, 1955 were conducted to determine the distribution of selected lipids, proteins, and amino acid radicals. Larvae and adult nematodes showed little neutral lipid (Oil Red O and Sudan III + IV techniques) in the mouth and esophageal regions; however, accumulation of lipid material occurred throughout the intestine in the form of globules which colored intensely with the dyes used. These globules disappeared with fat solvent extraction. In the intestines of females, accumulation of neutral lipids did not occur in the ventricular region; fat globules were distinctly posterior to this area. Germinal cells in the ovaries and oögonia stained strongly with Oil Red O and the Sudans. Following egg wall formation, dye solutions did not penetrate and a transition from staining to non-staining was obtained corresponding to degree of egg development. A subcuticular lipid layer was apparent in larvae and adults in both sexes.

A high concentration of protein (Bromophenol Blue method) was found in the areas of the procorpus, median bulb, isthmus and basal bulb. Germinal cells, oögonia, and morulae stained deeply, but eggs containing first stage larvae did not. In male nematodes, proteins were in high concentration in all parts of the reproductive system. Tryptophan radicals (p-dimethyl-aminobenzaldehyde procedure) were concentrated in older spermatogonial cells and *vas deferens*. An increase in tyrosine (Millon's test) accompanied maturation of germinal cells so that in the male, the most intense reaction was in the seminal sac. Structures showing a high concentration of arginine were the germinal cells, eggs, and sperms; no difference in concentration in different parts of the reproductive system was apparent.

Effect of Aquatic Plants on Nutrient  
Depletion from Sewage Enriched Water

H. Rogers and D. E. Davis

Department of Botany and Plant Pathology  
Auburn University, Auburn, Alabama

In order to test the possible effect of aquatic plant species on certain nutrients in sewage enriched water, six plastic pools were filled with a mixture of 25% sewage effluent and 75% well water. Plants were placed in three of the pools in each group of six; the plants were waterhyacinth, alligatorweed, curly pondweed, egeria, and slender naiad. The water in each pool was analyzed for phosphate at intervals for 6 months. During the first 2 months phosphate content in the sewage effluent from pools with plants decreased from 1.12 ppm to 0.17 ppm compared with a reduction from 0.98 ppm to 0.34 ppm in pools without plants. The phosphate content of well water remained at the relatively same low level with very little fluctuation regardless of whether plants were present or not.

## Abstracts

### The Amphibians of Mobile County, Alabama

A. Floyd Scott  
University of South Alabama  
Mobile, Alabama

Collections of amphibians in Mobile County, Alabama were made from January 1, 1968 to March 31, 1970. Specimens were captured by a variety of techniques and were fixed in 10% formalin and stored in 40% isopropyl alcohol. Three area university collections were surveyed and the results incorporated into the study. Thirty-nine species were anticipated to occur in Mobile County; 31 of these were taken or observed in one or more of the area university collections. No unexpected species were encountered.

Some Ecto- and Endo-parasites of the Cattle Egret,  
*Bubulcus ibis* (Aves, Ciconiiformes, Ardeidae), in Alabama

Jeanne J. Stuart and John F. Dismukes  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

The parasites of the cattle egret, a relative newcomer to the United States, have been studied little in this country, with no published accounts of internal parasites. Two birds from central Alabama and six from south Alabama were examined for external and internal parasites. External parasites found were the chewing louse, *Ciconiphilus decimfasciatus* (Mallophaga), and the hippoboscoid fly, *Ornithoica confluenta* (Diptera, Hippoboscidae). Internal parasites found were *Physaloptera* sp. (Nematoda, Physalopteridae), probably an accidental; *Habronema* sp. (Nematoda, Spiruridae); and *Hadjelia* sp. (Nematoda, Spiruridae). Numerous specimens of *Microtetrameres spiralis* (Nematoda, Tetrameridae), several specimens of *Synhimantus invaginata* (Nematoda, Acuariidae), and a single specimen of *Nephrostomum ramosum* (Trematoda, Echinostomatidae) were recovered. These latter three species are of especial importance, as all are recorded here for the first time in the Western Hemisphere.

### Effect of Free Moisture on Cercospora Leafspot Development on Peanuts

F. J. Subirats, J. A. Lyle, E. M. Clark, and P. A. Mott  
Department of Botany and Plant Pathology, and U. S. Weather Bureau  
Auburn University, Auburn, Alabama

Research was conducted during 1969 to determine the effect of free moisture on the development of *Cercospora* leafspot. Moisture was determined by changes in electrical resistance with sensors placed in peanut rows at three different height levels and connected to an Agricultural Meteorological Data Logging System.

Symptom expression of *Cercospora* leafspot occurred not less than 8-10 days from time of inoculation, but required 12-15 days to become visible on the leaves. Thus, early symptoms may be overlooked when determined visually. Development of *Cercospora* leafspot was correlated

with increased periods of moisture from 12-60 hours. Leaf samples collected bi-weekly showed high incidence of *Cercospora* infection when periods of wetness were 18 hr or higher and occurred 12-15 days prior to sampling.

### Microautoradiography of $^{14}\text{C}$ -labeled Plant Tissue

A. R. Whiteley  
Auburn, University

Cotton (*Gossypium hirsutum* L.) plants were grown with the root system in liquid nutrient solution until emergence of the first true leaf and transferred to a plexiglass chamber. After equilibration in the new environment,  $^{14}\text{CO}_2$  was admitted to the chamber and the plants were allowed to carry on photosynthesis for 10 minutes. Following fixation, the plants were allowed to translocate  $^{14}\text{C}$ -labeled compounds from the leaves to other plant parts for 1 to 6 hr. Samples of tissue were removed and fixed in a solution of formalin, acetic acid, and alcohol. Fixation of tissue was followed by dehydration in alcohol, and paraffin blocks were made. The tissue was cut into 25  $\mu$  sections, mounted on slides, de-paraffinized, and re-hydrated. Slides were coated with a nuclear track emulsion under a photographic safelight and placed into an air-tight box containing dessicant and an inert atmosphere. After three or more weeks, the slides were removed, developed as photographic film, and passed through a sequence of staining solutions. Finally the slides were covered and photographed under the microscope.

Dark spots indicating tracks left by  $^{14}\text{C}$  beta particles were observed. Location of the tracks corresponded to that part of the tissue section which contained the radiocarbon. The heaviest concentration of radioactivity appeared to be in the regions of rapid growth in the cambial regions and on the insides of conducting cells.

### The Winter Birds of Wheeler National Wildlife Refuge--1969-1970

George Williams, Jr.  
Department of Biology  
Athens College, Athens, Alabama

Wheeler National Wildlife Refuge is located on the Wheeler Reservoir of the Tennessee River in North Alabama. During the winter of 1969-1970, a census was made weekly by Refuge personnel either by a 5-day count, or by aerial estimate. A Christmas Bird Count was also conducted on December 20, 1969. There were 39,500 large Canada geese, 150 small Canadas, 1,500 blue geese, and 75 snow geese present at the peak of the season. The surface feeding ducks included 47,330 mallards, 3,000 black ducks, 5,000 baldpates, 7,000 pintails, 300 gadwalls, 300 green-winged teal, and 400 shovellers. The diving ducks included approximately 25 redheads, 20 canvasbacks, 200 ring-necked ducks, 250 hooded mergansers, 30 common mergansers, 20 red-breasted mergansers, 100 scaups, 25 common golden-eyes, 50 buffleheads, and 50 ruddy ducks. On the Christmas Bird Count a common egret, a barnacle goose, and a bald eagle were seen. The barnacle

## Abstracts

goose was a state record. Six lapland longspurs were also sighted. A blackbird roost of one million was observed on the Christmas Count. There were approximately 750,000 starlings, 150,000 red-winged blackbirds, 50,000 grackles, and 50,000 cowbirds.

### Adverse Effects of Industrial Wastes on the Biota of the Black Warrior and Tombigbee Rivers

Louis G. Williams  
Department of Biology  
University of Alabama, University, Alabama

Based on the species diversity of the naturally occurring biota and on communities of organisms cultured in the laboratory and suspended in the rivers in special perforated polyethylene bags, the Black Warrior and Tombigbee Rivers show highest water quality in spring following scouring out actions from high stream flow, and the poorest water quality in the late summer and early fall. But erratic stream flows make predictions difficult.

### Preliminary Study of the Food Habits of the Rosefin Shiner, *Notropis ardens*

Nalria Jean Wisdom  
Florence State University  
Florence, Alabama

Contents of the stomachs of 172 fish collected from the Cypress Creek watershed, Lauderdale County, Alabama, during December, 1968, May, June, July, August, September, October, November, December, 1969, and January, February, and March 1970, were examined. Nineteen percent were empty and the remainder contained the remains of 1 to many of a variety of arthropods. Terrestrial insects formed the predominant food item. Specimens collected in November and December contained small seeds and unidentified plant material.

### Spring Vascular Plants of the Big Creek Lake Biological Station, Mobile, Alabama

Eugene Wofford and David L. Scott  
University of South Alabama  
Mobile, Alabama

During the spring of 1968 and 1969, vascular plants were collected within the area of the Big Creek Lake Biological Station. A total of 163 species, representing 117 genera and 64 families was recorded. Voucher specimens were deposited in the University of South Alabama herbarium.

## CHEMISTRY

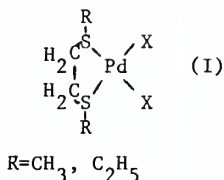
## Electron Structure and Stereochemistry in 2,5-dithiahexane and Related Ligand Palladium(II) Complexes

M. A. Blair and D. A. Zatzko

Department of Chemistry

University of Alabama, University, Alabama

Compounds of general form (I) have been made and characterized by elemental analysis, IR, VIS, and NMR spectroscopy. The proton chemical shifts of the  $\text{CH}_3$ 's in (I) with the substituents  $\text{X}=\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ , and  $\text{SCN}^-$ , can be correlated with the electronic and spacial requirements imposed by the X's. At room temperature for the  $\text{Cl}^-$  complex with 2,5-dithiahexane, two peaks occur for the methyls instead of the one which would be expected. By lowering temperatures, similar behavior was noted throughout the series. The NMR of these dithiahexane complexes indicates an equilibrium between two slightly different configurations for the methyl groups. Variable temperature NMR studies down to 5 C in DMSO and -40 C in  $\text{CH}_3\text{CN}$  have determined the coalescence temperatures ( $T_c$ ) of the various complexes. Both ( $T_c$ ) and the relative intensities of the two methyl peaks correlate with the size of the halide or pseudo-halide in the complex. In the case of the  $\text{SCN}$  the ( $T_c$ ) vs. Van der Waals' radius is off the straight line correlation observed for  $\text{Cl}^-$ ,  $\text{Br}^-$ , and  $\text{I}^-$ . This can be explained by a  $\text{SCN}$  rotation about the  $\text{Pd-S}$  bond to sweep out a cone and increase the effective Van der Waals' radius. Activation energy between the two configurations is of the range ~ 16kcal/mole.



## Some Studies Concerning a Method for Estimating the Saccharin Content of Liquid Foods

Julius D. Capps and Gerald C. Quinn

Department of Chemistry

Auburn University, Auburn, Alabama

It was shown that an essentially linear relation exists between the absorbance of water solutions of saccharin acid and the concentration in the range of  $0.2 \times 10^{-5}$  to  $3.6 \times 10^{-5}$  g/ml at 234.5 mμ. This fact was incorporated into a method for estimating the saccharin content of dietary cola beverages. Certain interfering substances were removed by extracting with chloroform under basic conditions; however, benzoic acid was also shown to interfere and it was removed by extracting under acidic conditions with carbon tetrachloride. The saccharin was then extracted with ethyl ether yielding a solution from which the saccharin could be separated. This was then put into solution in water and diluted to the proper concentration range for reading the absorbance at 234.5 mμ. Absorbance was then related to the amount of saccharin by reading from a working curve.

## Abstracts

### The Mechanism of the Favorsky Rearrangement of 1,1,3-Tribromoacetone. Evidence for a Bromocyclopropenone Intermediate

Donald R. Cowsar  
Southern Research Institute  
Birmingham, Alabama

The Favorsky rearrangement of halogenated ketones has found many applications in organic synthesis. Many examples of rearrangements of monohalogeno ketones to carboxylic acids have been reported and several mechanisms are still being considered. In recent years, studies of the base-induced reactions of di- and trihalogeno ketones have yielded some interesting results regarding both the synthetic utility and the mechanism of the Favorsky rearrangement. Treatment of 1,1-dihaloketones with non-nucleophilic bases provides a route to cyclopropenones, while treatment with nucleophilic bases affords *cis*- $\alpha,\beta$ -unsaturated carboxylic acids (or esters). The Favorsky rearrangement of 1,1,3-tribromoacetone in aqueous carbonate or bicarbonate has been reported by Rappe (Acta Chem. Scand. 19:31, 1965) to yield exclusively *cis*- $\beta$ -bromoacrylic acid. However, in an investigation of the applicability of the Favorsky reaction to the synthesis of bromocyclopropenone and ultimately hydroxycyclopropenone (Cowsar, Donald R. 1969. Ph.D. Dissertation, Rice University) 1,1,3-tribromoacetone was found to yield *trans*- $\beta$ -bromoacrylic acid in addition to *cis*- $\beta$ -bromoacrylic acid. It is proposed that *trans*- $\beta$ -bromoacrylic acid results from the intermediacy of bromocyclopropenone.

### Reactions of Grignard Reagents with Indene, Fluorene, and Their Heterocyclic Analogues

Glenn A. Gossett and J. L. Atwood  
Department of Chemistry  
University of Alabama, University, Alabama

The heterocyclic series pyrrole, indole, and carbazole is iso-electronic with the series cyclopentadiene, indene, and fluorene. Organomagnesium compounds have been isolated from the reaction



Characterization of the compounds was accomplished by a study of chemical reactivity and mass spectrometry. Although several structures are possible, evidence indicates that bis(indenyl)magnesium exhibits a sandwich structure analogous to that of bis(indenyl)iron.



The Chemistry Curriculum and its Implementation  
at a University College in Ghana

Fred A. Griffiths  
Huntingdon College  
Montgomery, Alabama

Much has been said and written about what and how to teach chemistry in the American Colleges and Universities. During a year of teaching as a Fulbright Professor in Ghana a new approach was found. We might say if in the American system the presentation is vertical, then in Ghana it is on the horizontal. This means that here we usually teach one or two courses through a year or for a set number of terms. There, the system would give all the usual branches of undergraduate chemistry at the same time. For instance a freshman would take physical, inorganic and organic under different professors each week. The same holds, at a higher level in each succeeding year. Laboratory was mostly quantitative. Year-end exams provided a basis for promotion to the next level.

Separation and Identification of Organic  
Compounds in Pecan Hulls

Sammy W. Ingram, Jr.  
Troy State University  
Troy, Alabama

About 260 g of pecan hulls were refluxed with a liter of 5% NaOH for several hr, decolorized, filtered while hot and filtrate let stand for several weeks resulting in a blackish soup. Two 20 ml portions of the soup were treated, respectively, with 200 ml of buffer solutions at pH 4.4 and 5.6. A 300 ml portion of the soup was treated with 400 ml of a buffer at pH 7.6. The three solutions were allowed to stand for several weeks, after which they were separately extracted with benzene, and the benzene extracts were separately subjected to columnar chromatography, using alumina as the adsorbent. Elution of possible compounds from each benzene extract was carried out using benzene and ethyl alcohol. In all, 16 elution fractions were collected--about five fractions for each of the benzene extracts. Solvent was evaporated from the fractions to see if significant residues could be obtained. Significant residues were obtained--yellow solids or oils of peculiar odor. The residues were redissolved in the respective solvents which were evaporated and infrared absorption spectra were recorded. The spectra were carefully studied and a tabulation was made of all non-solvent bands.

Study of the spectra indicated that further work on the problem is needed. Some of the compounds were suspected to be para-disubstituted benzenes or 1,2,3,4--tetrasubstituted benzenes with functional groups of a carboxylic, phenolic and ether nature. The experiment was repeated with about 350 g of pecan hulls; 19 residues, some of which were present in larger amounts than before, were obtained. In an attempt to remove

weakly basic compounds, remains of the hulls from the original treatment with 5% NaOH were dumped into concentrated sulfuric acid and allowed to stand several weeks. Zinc-dust distillation and dry distillation of pecan hulls are anticipated, and any products from these distillations may be subjected to carbon-skeleton chromatography.

A Mechanistic Study of the Formation of By-products  
in the Nitration of Pentachlorobenzene

T. G. Jackson and J. E. Norris  
University of South Alabama  
Mobile, Alabama

Pentachloronitrobenzene is an extensively used soil fungicide and seed dressing. The product is used in areas where such crops as cotton, peanuts, sugar cane, and lettuce are grown. One method used for the production of pentachloronitrobenzene is the direct nitration of pentachlorobenzene. We have observed that some hexachlorobenzene is formed as a by-product during the nitration process. A study of the nitration process, in order to establish the mechanism for the formation of the hexachlorobenzene, has been conducted.

Reactions of Electron Deficient Boron Cage Systems with Cyclopropane

E. B. Overton and C. L. Bramlett  
Department of Chemistry  
University of Alabama, University

It is now well established that reactions of boron hydrides with alkynes yield carboranes. Reactions with saturated hydrocarbons have been studied only in the case of diborane. In this paper, reactions of pentaborane (9) and 2,4-dicarbahexaborane (8) with cyclopropane and propene will be discussed from the standpoint of reaction conditions and products.

Electronic Absorption Spectra of Carbon Subsulfide

Lawrence C. Robertson and James A. Merritt  
Physical Sciences Laboratory  
Redstone Arsenal, Alabama

The electronic absorption spectra of gaseous carbon subsulfide at 4850 Å and 2375 Å have been obtained. The first electronic system at 4850 Å consists of multiple bands and the second electronic system of approximately 15 bands is found around 2375 Å. Photolysis of the carbon subsulfide thus far has precluded obtaining spectra in the vacuum ultra-violet region. (Paper presented at 46th Annual Meeting AAS, April, 1969).

The N-methyl Derivatives of Borazine

A. T. Tabereaux and C. L. Bramlett  
Department of Chemistry  
University of Alabama, University

Interest in borazine,  $B_3N_3H_6$ , arises in part from its similarity to benzene in structure and physical properties. Relatively little is known of its chemistry, principally because of difficulties involved in the original synthetic procedures for borazine and its derivatives. Only a few borazine derivatives which are unsymmetrically substituted with respect to one or both of the skeletal atoms have been reported. As part of a general study of the mechanism of cleavage of  $B_5H_9$  we have found that  $H_3B_3N_3H_3$ ,  $H_3B_3N_3H_2CH_3$ ,  $H_3B_3N_3H(CH_3)_2$ ,  $H_3B_3N_3(CH_3)_3$ , and  $\mu-CH_3NH B_2H_5$  can be prepared in a series of reactions involving  $B_5H_9$ ,  $NH_3$  and  $CH_3NH_2$ . The presence of  $\mu$ -methylaminodiborane also suggested a possible mechanism for the formation of the borazine ring in which  $B_5H_9$  and the amine(s) react to form  $\mu$ -methylaminodiborane followed by conversion to the borazine ring system.

Reactions involving 1-methylpentaborane and simple amines yield unsymmetrical derivatives with respect to both boron and nitrogen in the borazine ring, depending on the reaction conditions.

The Structure of Dimethylberylliumdiquinuclidine

C. D. Whitt and J. L. Atwood  
Department of Chemistry  
University of Alabama, University

A crystalline product  $(CH_3)_2Be(NC_7H_{13})_2$  was obtained from the reaction of dimethylberyllium and 1-azabicyclo [2,2,2] octane (quinuclidine) in a benzene-hexane solution. The crystal structure has been determined from visually estimated three-dimensional x-ray film data, and refined to final R value of 14% by the least-squares technique for the 739 independent observed reflections. The material crystallizes in the space group  $C_{2h}^5-P2_1/c$  of the monoclinic system with cell dimensions  $a = 10.95 \text{ \AA}$ ,  $b = 12.71 \text{ \AA}$ ,  $c = 12.15 \text{ \AA}$  and  $\beta = 113.0^\circ$  with four formula units per unit cell giving a calculated density of  $1.12 \text{ g/cm}^3$ . Coordination about the beryllium atom is tetrahedral with two quinuclidine and two methyl groups bonded to the beryllium. A monomeric molecule of dimethylberylliumdiquinuclidine possesses no crystallographic symmetry.

GEOLOGY

Origin of an Oyster Bank in the Eutaw  
Formation (U. Cretaceous) of Eastern Alabama

Warren A. Bacon and Ronald S. Taylor  
Auburn University, Auburn, Alabama

Three miles south of Marvin, Russell County, Alabama, on Alabama Highway 37, a road cut exposes oyster-rich mudstones and limestones of the

Eutaw Formation. The predominant shell contributor to the bank assemblage is the small ovate Cretaceous oyster, *Ostrea cretacea*. The exposed *O. cretacea*-bearing beds exceed 100 feet in thickness and are of unknown lateral extent beneath a prominent ridge. Study techniques included random-sampling, insoluble residues, grain-size analysis, thin sections, valve measurements, and valve position determinations. General characteristics of the oyster beds included a variable density of oyster shells, excellent preservation of shells, presence of complete shells, a fine-grained sediment matrix, and a complete sequence of growth stages. The associated fauna was apparently limited to occasional specimens of *Anomia tellinoides* and a pectinid.

On the basis of sedimentological evidence, the oyster bank was interpreted as an *in situ* assemblage. The evidence further suggested that *O. cretacea* had ecologic requirements similar to those of living oysters. The requirements included a water depth of less than 20 feet, brackish water, moderate turbidity, and restricted water movement.

#### Fossil Calendars and the History of the Earth-moon System

George F. Brockman  
Southern Research Institute  
Birmingham, Alabama

Annual, fortnightly, and daily growth lamellae are visible on many types of fossils. Correlation of the relative lengths of the day, the synodic month, and the year are presented, based on published and new data. The lengths of the day and the month have increased by about 13% and 7%, respectively, since the end of the Cambrian Period, and the rate of change has decreased to about one-third of that at the close of the Cambrian Period.

The presumed rotational information was substituted into standard equations to determine apparent changes in the inertia and kinetic energy of the earth and the moon and the potential energy of the moon. These are entirely consistent with prior information. The data indicate that the moment of inertia of the earth has not changed by more than about 1%, a piece of information about which no physical data were previously available.

The coefficient of friction of the tides has decreased to about four-tenths of its value in the Cambrian Period with the withdrawal of the Paleozoic epicontinental seas.

#### Graphic Interpretation of Sediment Environment of the Southwest Alabama Gulf Coast

Barry Burgess  
University of Alabama, University

Forty-seven sediment samples were taken along the southwest Alabama Gulf Coast from two distinct environment types -- off-shore and

barrier island. Samples were analyzed on the basis of texture and the results of the analysis were used in calculating statistical parameters - coarseness, skewness, deviation measure, mode, and median. Through the use of graphs of these parameters it is possible to determine from what type environment the sample was taken. The Phi Median - Phi Deviation Graph shows the most definite results. To a lesser extent the Phi Mode - Phi Deviation Measure Graph and the Phi Median - Phi Skewness Graph can be used in sediment environment interpretation.

A Silicified Wood from the Northern Margin  
of the Alabama Coastal Plain

Elizabeth Cahoon  
Department of Geology  
Auburn University, Auburn, Alabama

Petrified logs are commonly found in the beds of streams that cut the northern margin of the coastal plain. The trees these logs represent have not been identified. Extensive collections of silicified wood were made from the base of a channel fill cut into Middle Cretaceous sediments in Tuskegee National Forest. On present evidence, the deposit could be any age from Middle Cretaceous to Pleistocene. Wood from this and several other localities was thin-sectioned and studied anatomically. Most of the specimens were of one peculiar type: with scattered vessels and no growth rings. Vessels were characteristic of dicotyledonous angiosperm wood. Growth rings are absent from the wood of some modern tropical trees. Detailed study indicated that this Alabama wood belonged to the form genus *Paraphyllanthoxylon*. Other species of this genus have been found in the Colorado Group in Arizona, and the Lower Cretaceous of Idaho and Utah. This wood was not identical to any living trees, but was most similar to tropical trees in the families Euphorbiaceae, Anacardiaceae and Burseraceae. The widespread occurrence of this species of wood in Alabama suggests that there may have been a distinct period of wood petrification.

A Structural Analysis of the Jeff Price Mine,  
Cave-in-Rock, Illinois

W. Eugene Chapman  
University of Alabama, University

The Jeff Price mine is located along the uppermost of three ore-bearing horizons in the strata-bound deposits of the Cave-in-Rock Fluorite District, just below the contact between the Downeys Bluff Limestone and the overlying Bethel Sandstone. Structural features in the mine consist of a NE-SW trending synclinal trough marked by two pronounced depressions, one a large, oval breccia "pipe" at least 40 feet deep and the other a canoe-shaped, doubly plunging syncline with a depth of 20 feet; faults, joints, and a series of parallel, NE-trending "v's" varying in depth from one to ten feet. The faults are mostly normal, most commonly trend N45E, and usually have displacements of a foot or less, although a few faults are present which may have displacements exceeding ten feet. Results of

## Abstracts

a detailed joint analysis indicate that a N45E-N45W joint set, possibly shear joints, pre-dated mineralization and appear to have controlled the development of "V" structures by serving as conduits through which the ore-forming solutions could migrate. Therefore the "V's", which have an apparent dominant trend of N45E, may be considered to be essentially a variety of mineralized fracture.

### Sediment Distribution Along the Southwest Coast of Alabama

W. Eugene Chapman and George F. Moravec  
University of Alabama, University

Forty-eight samples representative of estuarine, lagoonal, continental shelf, and barrier island environments were collected and analyzed during the summer of 1969. Estuarine and lagoonal sediments were mainly silts and clays with fine-to medium-grained sand erratics, while continental shelf sediments were predominantly fine sand with local accumulations of silt and clay. Barrier island sediments were fine to coarse, water-deposited sands which had been partially reworked by wind action. Barrier island sediments were distinguishable from the other sediment types because they were coarser and better sorted, and were transported by traction, while all other sediments in the area were characteristic of transportation by composite traction and suspension.

### Barite Deposits in Bibb County, Alabama

Danny M. Dobbs  
University of Alabama, University

The "sinks" district in Bibb County, Alabama, contains several isolated pockets of barite. This barite occurs as veins in limestone and is associated with fluorite and calcite as major gangue minerals. Structural control appears to play an important role in the area with most of the barite occurring along definite trends. Due to the nature of occurrence of the deposits and the minerals present, this is thought by the writer to be a hydrothermal ore deposit. Some idea as to the composition of the original solutions is obtained by setting maximum and minimum concentration ratios on some of the major ions. Most of the minerals present show a fairly definite paragenetic relationship to each other.

### A New Species of Dermatemydid Turtle

James L. Dobie  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

The genus *Hoplochelys*, previously known from only Eocene deposits in North America, is now reported from an upper Cretaceous deposit. The remains of two individuals (AUMP 295 and 644) were found approximately 8 and 60 years ago in the extreme Southwestern portion of Lowndes County,



Alabama. Measurements of the remains of the two specimens were compared with those reported for the seven described species of *Hoplochelys*. It appears that the Alabama material represents a new species of *Hoplochelys*.

#### Definition of the Coosa Deformed Belt

James A. Drahovzal and William A. Thomas  
Geological Survey of Alabama, University and  
Birmingham-Southern College, Birmingham, Alabama

The Coosa deformed belt is a narrow linear zone of discontinuous, thin, imbricate thrust sheets on the southeast flank of the Coosa syncline in the Valley and Ridge of Alabama. The deformed belt is over-ridden on the southeast by the Pell City overthrust, the emplacement of which was probably the mechanism for the small scale imbricate thrusting. The Coosa syncline is formed in the Carboniferous clastic sequence and the Pell City overthrust block consists of the Cambrian-Ordovician Knox Group and older rocks. The Coosa deformed belt generally includes a stratigraphically variable interval of beds ranging in age from Ordovician to Mississippian.

The relatively straight alignment of the deformed belt is interrupted by two zones of transverse offset: right lateral displacement of 5 miles near Reads Mill and left lateral displacement of 6 miles near Harpersville. The Reads Mill right lateral displacement includes a tectonic megabreccia and fold complex of Fort Payne and Frog Mountain beds and apparent transverse faults in the Knox Group. Northeast of the Reads Mill right lateral displacement, the Coosa syncline is bisected by a large medial anticline which terminates southwestward at the zone of right lateral displacement; the Coosa deformed belt is limited to a narrow strip along the southeast flank of the medial anticline. The Harpersville left lateral displacement includes imbricate thrust sheets of Knox-Athens beds and probable transverse faults in Fort Payne-Parkwood rocks. To the southwest of the left lateral displacement a group of low domes suggests a possible continuation of the deformed belt to Columbiana Mountain. The central segment of the belt between the two zones of lateral displacement is characterized by relatively long, narrow thrust sheets of Ordovician-Mississippian beds. Near each end, the central segment includes tectonic megabreccia of Fort Payne blocks and a few thrust slices of Knox. In the northeastern part of the central segment, some thrust slices contain a thick sequence of Frog Mountain Sandstone, but at the southwestern end, the Frog Mountain is unconformably absent.  
(Approved for publication by Alabama State Geologist)

#### Definition of the Upper Ordovician of Alabama

Thornton L. Neathery, James A. Drahovzal and Dorothy E. Raymond  
Geological Survey of Alabama  
University, Alabama

The redefinition of the Chickamauga Limestone of Alabama has brought about the need for definition of Ordovician rocks corresponding in lithology

and stratigraphic position to the Upper Ordovician strata of Tennessee. Over much of north Alabama rock units here defined as the Sequatchie, Inman, and Leipers Formations have been recognized. These rocks form a wedge of carbonate detrital rocks between the redefined underlying Chickamauga Formation and the overlying Red Mountain Formation. The sequence overlies unconformably the Middle Ordovician Limestones of the Nashville Group, which thins to the south. The southeast outcrop limits of the interval have not been determined, but regional reconnaissance indicates that the interval can be recognized along the northwest frontal edge of the Valley and Ridge physiographic province. To the southwest in the Birmingham area, the interval is represented by thin outcrops of a distinctive bioclastic limestone.

In the Tennessee Valley area, the Inman consists of gray, maroon, and green calcisiltite and calcilutite; Leipers is mostly a dark gray calcarenite. The Sequatchie is the most widespread unit of the Upper Ordovician and consists of interbedded maroon and gray-green calcisiltite, calcarenite, calcirudite, and calcareous mudstone. Along the margin of the Valley and Ridge, the Sequatchie becomes less calcareous and grades into deltaic sediments similar to those of the Juniata Formation of northeast Tennessee. Richmondian fauna, including *Lepidocyclus capax*, *Dinorthis retrosa*, *Rhipidognathus symmetrica symmetrica*, and *R. symmetrica discreta* have been found in outcrops mapped as Sequatchie. (Approved for publication by the State Geologist, Geological Survey of Alabama)

## Geologic and Hydrologic Research Through Space Acquired Data for Alabama

William J. Powell, Charles W. Copeland, and James A. Drahovzal  
U. S. Geological Survey, University, Alabama and  
Geological Survey of Alabama, University

Four multispectral photographs of east-central Alabama were taken by the crew of Apollo 9 spacecraft. The photographs cover a 6,400 square mile area just east of Birmingham, Alabama, and show portions of the Piedmont, Valley and Ridge, and Cumberland Plateau Provinces. General distribution and structural configuration of resistant, ridge-forming rock units are generally evident and agree reasonably well with the 1926 Geologic Map of Alabama.

One of the most striking features revealed by the photographs are the relatively straight, long lineations which intersect Appalachian structural axes. Because little or no offset in topographic features is evident along most of the traces, the lineations are thought to represent fractures. Orientation analyses suggest that the fractures resulted from a reoriented stress field developed sometime after the main phase of Appalachian mountain building. Apparent coincidence of the lineations with areas of known anomalies in stream flow, large capacity wells and springs, quarry drainage problems and dam leakage problems suggests that the lineations may have not only a marked geologic effect, but also be of great hydrologic, environmental, and economic significance. (Approved for publication by Alabama State Geologist)

The Location and Definition of Alluvial Aquifers Along the Alabama River  
by Geophysical, Photogeology, and Auger Test Drilling Methods

Leon Scarbrough  
Geological Survey of Alabama  
University

This study includes applications of photogeology, geophysical, and auger test drilling methods in the flood plain of the Alabama River to locate, map, and define deposits which would be good shallow aquifers with definite potential for hydraulic connection to the river. Photogeology was used to locate potentially good areas as interpreted from aerial photographs of the area. The potentially good areas were then worked and drilled for verification of photogeology and geophysical data. Using the assumption that sand and/or gravel bodies would be more resistive than the associated clay and silt deposits, electrical resistivity became the primary tool of exploration.

Photogeology proved to be a competent method of predicting good areas to be worked. The alluvial deposits were located and mapped and verification completed with auger test drilling.

Processes Which May Result in the  
Concentration of Mineral Species on the Moon

Reynold Q. Shotts  
University of Alabama, University

Beginning with nine earth mineral concentrating processes discussed by Bateman in his *Economic Mineral Deposits*, concentration mechanisms possibly operative on the moon are discussed from two standpoints: (1) which of the nine are most likely to have operated and (2) which are eliminated by the lunar environment (past and present) and what new or different processes may have operated?

The lunar environment appears to eliminate sedimentation (inorganic and organic), oxidation and supergene enrichment and dynamic metamorphism. Magmatic concentration and hydrothermal processes, while probably operative, have produced few, if any, hydrous or other fluid-bearing ores of greatest interest. In the absence or scarcity of surface fluids, residual and mechanical concentration probably has been weak or lacking.

Sublimation, contact metasomatism, evaporation and shock metamorphism probably have been the predominating processes. The latter probably was unimportant in producing hydrous minerals, except in combination with metasomatism. (Paper presented at 46th Annual Meeting AAS, April, 1969)

## Abstracts

### Quantitative Geomorphology, A Common Link Between Hydrologists and Geomorphologists

B. C. Spigner  
Geological Survey of Alabama  
University

Hydrologists have long recognized that the physiography of a region has a major effect on the hydrology of drainage basins within that region. They have also acknowledged that the geometry of a drainage basin affects the flow characteristics of streams within that basin. Given quantitative procedures for terrain analysis by R. E. Horton, W. B. Langbein, A. N. Strahler and others, hydrologists have related geomorphic parameters of basins to stream discharge, flood-frequency analysis, basin sedimentation and other hydrologic and geologic parameters. However, disagreements have arisen on basic procedures of stream ordering, map accuracy, and choices of morphometric parameters to use in multiple regression analyses.

Several morphometric parameters have been evaluated and applied to selected watersheds with differing physiography in west-central Alabama. The ordering techniques of Horton and Strahler have been compared and evaluated. Strahler's ordering technique results in a more accurate representation of the law of stream numbers than does Horton's technique. Results of the study confirm previous conclusions that this law is a statistical concept which results from Strahler's ordering technique. This study provided a more precise definition of stream ordering which is lacking in previous publications. Authors must clearly define and illustrate their stream-ordering technique to prevent confusion and aid replication by subsequent investigators. Topographic maps of the scale 1:62,500 were tested for accuracy by field survey and were found to be inaccurate when only the drainage net shown in blue on the map is used in calculations. However, this problem can be minimized by using contour inflections, extending the drainage net to mesh length, and being consistent with procedures of assigning stream channels. Detailed field mapping of drainage nets is unwarranted provided the investigator is familiar with the general geology and hydrology of the terrain with which he is working.

The ultimate goal of quantitative geomorphology is to aid in the accurate prediction of streamflow characteristics. Streamflow records are a necessity if geomorphic parameters are to be correlated with stream discharge. The lack of streamflow records in the study area limits correlations of basin morphometry and stream discharge. However, as more streamflow records become available on small-area watersheds, correlation of geomorphic parameters to discharge will add a common denominator to fluvial geomorphology and hydrology.

Stratigraphy and Historical Geology of Part of the  
Talladega Group in Northern Chilton and  
Southern Shelby Counties, Alabama

Ray N. Warren  
Albuquerque, New Mexico

The mapped area, located in the Ashland Plateau portion of the Alabama Piedmont Province consists of folded, faulted, and metamorphosed sedimentary beds of the lower and middle part of the Talladega Group. The rocks are believed to have been deposited in a subsiding trough (Columbiana Trough) formed in Carboniferous time.

The stratigraphic sequence of the rock units exposed in the mapped area, from oldest to youngest, is the Waxahatchee Slate and its Sawyer Limestone Member, the Brewer Phyllite, the lower Wash Creek Slate, and the Stumps Creek Tongue of the Wash Creek Slate (named herein). The total thickness of the sequence is approximately 4,000 feet.

The metasediments represent shallow water, coastal-lagoonal, and swamp environments and are characteristic of the flysch depositional phase of the tectonic cycle. There are two major facies relationships within the mapped area: (1) a limestone facies which is limited to the axial portion of the trough of deposition and its clastic sandstone facies which occurs along the flank of the trough to the southwest of the limestone and (2) a northeast-southwest trending ferruginous sandstone facies and its shale facies to the southwest.

Penecontemporaneous sedimentary slump features, and the relationship of the northeast-southwest facies to the marked thickening of the metasedimentary units toward the axis of the trough indicate that the uppermost Waxahatchee Slate, Brewer Phyllite, Stumps Creek Tongue of the Wash Creek Slate, and the Ferruginous Tongue of the Brewer Formation were deposited during the period of subsidence of the Columbiana Trough.

A local source from which the sediments could have been derived is from the relatively high areas adjacent to the Columbiana Trough. However, considering the lower and middle units of the Talladega Group to be equivalent in age to the Mississippian Floyd Shale and Parkwood Formation, then the sediment source may have been derived from the southwest.

FORESTRY, GEOGRAPHY, AND CONSERVATION

Distribution of Wild Turkey in Alabama

James R. Davis  
Alabama Department of Conservation  
Montgomery, Alabama

The wild turkey, *Meleagris gallapavo* spp., which once inhabited almost two-thirds of the continental United States all but disappeared in late 19th and early 20th centuries. In Alabama, the range decreased to less than 1,000,000 acres and the population to an estimated 13,000 birds



## Abstracts

during the late 1930's. Principal causes of this were destruction of range (primarily by agricultural interests) and lack of protection.

Re-establishment of this game bird in Alabama has been a success story of some proportion. Since World War II, the range of the wild turkey has expanded to near 24,000,000 acres of the approximately 33,000,000 acres of Alabama. Turkeys are presently established in all 67 counties and harvest is permitted in all or parts of 55 of these counties. Harvest in 1968 was approximately 30,000 turkeys.

Presently, the turkey range and population are expanding. This is expected to continue for several years, however, there is a point where the urban, reservoir and highway construction, and the forest management practice of clear cutting vast acreages on a 25-30 year pulpwood cycle will turn this trend downward. In some local areas, this has already been experienced. (Contribution from Federal Aid in Wildlife Restoration, project 35R, Work Plan II)

### Final Results of the Tuscaloosa Air Pollution Study

H. D. Hays  
University of Alabama  
University

This is a final report of the study on particulate pollution in the Tuscaloosa region during the years 1967-1969. Compared to cities of 100,000 population in the nation, Tuscaloosa ranked in the 67th percentile in suspended particulate concentration with a yearly average of  $97.73 \mu\text{g}/\text{m}^3$ . There were great intra-city variations at the ten collection stations depending on weather conditions and nearness to pollution sources. The composite averages for the ten stations were: organics,  $8.46 \mu\text{g}/\text{m}^3$ ; nitrates,  $.60 \mu\text{g}/\text{m}^3$ ; and sulfates,  $5.86 \mu\text{g}/\text{m}^3$ .

Beginning in October 1969, a group of concerned Tuscaloosa citizens demanded that the City Commission take steps to bring Tuscaloosa under certain air quality standards and force various pollution sources to take steps toward controlling pollution. Many heated meetings followed and as a final result of these efforts Tuscaloosa entered into the Birmingham Federal Air Quality Control District in December of 1969. The next step in this study will be to set up a gaseous research program.

### Nucleated Rural Nonfarm Settlement Patterns in Upper East Tennessee

David W. Icenogle  
Auburn University  
Auburn, Alabama

Upper East Tennessee, as defined in this paper, is a three-county area located primarily in the Appalachian Great Valley region, and centered on the four small cities of Johnson City, Kingsport, Bristol, and Elizabethton. In contrast to much of Appalachia, it is highly industrialized. Due largely to the pre-rural cultural bias of the population, most



of the industrial laborers who form the backbone of the economy have chosen to reside in isolated homes and in small nucleated communities scattered over the rural countryside.

In this paper a definition of rural nonfarm population is presented, which is perhaps applicable only locally. A classification of different types of nucleated population centers on a geographic basis is provided, in which four urban centers are identified, as well as 175 rural nucleated settlements. On the basis of exterior morphology, a classification of rural nucleated settlements into villages, suburbs, and hamlets has been devised. Nucleated rural nonfarm settlements include villages, hamlets, and residential suburbs, each of which illustrates definite geographical and sociological characteristics.

#### Perception of Region in Alabama

Walter F. Koch  
Department of Geography  
University of Alabama, University

The concept of environmental perception has added new dimensions to the study of geography. People see their environments differently--with images based on their education and group values. The names people give to regions and places are group oriented for ease of communication. Regions and places are basic to the appreciation of geography. How students see their environment affords a key to their geographical education. This study surveys the terminology used by University of Alabama students to describe the geographical sub-divisions of Alabama other than by political units.

The survey of perception indicated that Alabama students do not normally refer to regions in physiographic, economic, or cultural terms. They have a tendency to use compass directions to divide the state--even to describe their own locales. A parallel study of Alabama students' knowledge of the location of the state's major cities indicates a weakness in the elementary and secondary social science programs. The students demonstrated poor ability to locate cities on blank maps.

#### The Rutting Season of Alabama Deer

Francis X. Lueth  
Alabama Department of Conservation  
Montgomery

The rutting season is defined as the actual breeding season of the deer. There is some territory marking by the bucks that may precede the breeding season by as much as a month. Alabama deer breed over a period of nearly seven months. Breeding occurred during November on only five of twenty study areas. On three areas no deer conceived until after February 1. The peak of the breeding season occurred before February 1 on ten areas and after February 1 on the other ten. Each deer herd appears

## Abstracts

to have its own breeding season and there is no relation between time and a north-south geographical location. It is impractical and unnecessary to set Alabama deer seasons to conform with the rutting season; however, a mid-November opening and a mid-January closing of the gun deer season is suggested for the State.

### Compatibility of Forestry and Wildlife Management

Raymond D. Moody  
International Paper Company

It is a proven fact that some silvicultural practices of industrial timberland management are beneficial to wildlife. International Paper Company has eight full time Foresters with a graduate degree in Wildlife Management to assist in administering the Company's Wildlife and Recreation Program. Other companies have also employed wildlife personnel.

Many forest industry companies are planting wildlife food plots, and some of them are even going so far as to trap deer and turkey from their lands, in overpopulated areas, and transfer them to other lands under their control to provide better public hunting. Some companies are now engaged in setting up wildlife management areas of their own, and charging a nominal fee for hunting to offset the cost of planting and other management practices primarily directed toward wildlife habitat improvement and protection.

### Preliminary Report on White-tailed Deer Movements in River-Swamp and Flatwoods Areas in Sumter County, Alabama

D. Lamar Robinette and M. Keith Causey  
Alabama Cooperative Wildlife Research Unit  
and  
Department of Zoology-Entomology  
Auburn University, Auburn, Alabama

Thirty-nine white-tailed deer were trapped in baited box-type traps and marked with color-coded reflective ear discs to obtain census and movement data. The study was conducted on three areas in Sumter County, Alabama. These areas were located in a 6,000-acre river swamp, Interior Flatwoods, and a food-plot area located on a transitional zone between the swamp and the Flatwoods.

Movement data were obtained from 14 of the 39 marked animals. Nine marked deer were recaptured 13 times, and five tags from dead deer were returned. Four deer were recaptured in the same location over a period of a few weeks to two months. Recaptures of two of these four deer occurring in the same trap over a period of two months in the food-plot area and in the Flatwoods indicated no major shift in the center of activity ("core area").

Two deer were marked in the swamp in October and November of 1969. Both deer were recaptured twice between December 18, 1969, and February

11, 1970, 3.0 air miles from the original capture site; both were recaptured in the food-plot area. These deer could have shifted their core area or possibly their home range because of the depletion of a sparse mast crop in the river swamp; however, there is insufficient data to conclude this.

Further evidence that these deer may shift their core area or home range due to a seasonal change in food supply was obtained from a yearling doe marked in the swamp on November 18, 1969. This deer was killed by an automobile December 15, 1969, on a farm-market road 4.5 air miles from her capture site. She had moved from the swamp to the flatwoods study area.

Movement data indicating a shift from the food-plot area to the swamp were obtained from an adult doe. This deer was captured in the food-plot area in March of 1969 and recaptured 2.5 air miles away in the swamp during December of 1969.

Two tags returned from deer killed in the flatwoods study area indicated large home ranges for the deer in question. An adult doe was killed 2.5 miles from a point where she had been captured and recaptured several times during a two-month period. A buck was shot January 10, 1970, 2.25 miles from the site of his capture.

The apparent home-range base distance traveled by six of the marked deer was considerably greater than those reported for white-tailed deer in other Alabama studies.

#### Pecan Cultivation in Mobile County, Alabama

Glenn R. Sebastian  
University of South Alabama  
Mobile, Alabama

The pecan has been part of the agricultural scene in south Alabama for many years. Surprisingly, as a high risk crop it fits well into the economic structure of the community. Many individuals, as well as industrial concerns rely upon the harvest of this crop for their livelihood. The apparent problems created by a labor force relying upon such a high risk crop, produces an ideal area of observation and investigation by a geographer.

I have concluded that the present production figures for pecan could be doubled if proper spraying of the tree was done during foliation. This process is quite expensive, and most farmers do not adhere to recommendations of the agricultural scientists.

Most farmers supplement their pecan incomes with secondary products such as cattle or soybeans. This particular type of endeavor seems to be most advantageous, especially when faced with a natural catastrophe such as hurricane Camille.

The pecan, even though it is a high risk crop, can fit well into the

## Abstracts

economic structure of Mobile County. It is presently suffering from the effects of Camille, but with the help of secondary industries, the pecan should regain importance within a few years.

### Preliminary Results of Gassing Tests on Gopher Tortoises and Other Organisms Inhabiting Gopher Burrows

Dan W. Speake and Robert H. Mount  
Alabama Cooperative Wildlife Research Unit  
and

Department of Zoology-Entomology, Auburn University

Concern over possible harmful effects of the widespread use of gasoline to drive rattlesnakes out of gopher tortoise burrows prompted this investigation. To date, tests have been conducted at several localities in Alabama, Georgia, and Florida. Most tests have involved introducing varying amounts of gasoline into gopher burrows known to be inhabited by animals, excavating the animals after varying periods of time, and observing effects of the treatment. Test animals included gopher tortoises (*Gopherus polyphemus*), eastern diamondback rattlesnakes (*Crotalus adamanteus*), a coachwhip snake (*Masticophis flagellum*), opossums (*Didelphis virginiana*), and gopher frogs (*Rana areolata*).

Of all the animals tested, opossums, the only mammals used, appeared to be the most susceptible to the effects of gasoline. Neither of the two gassed made any attempt to leave the burrow and both were dead within two hours after treatment. The gopher tortoises gassed have, to date, shown no ill effects directly attributable to the gasoline. However, the cloacal regions of several were edematous, and two of these were parasitized by maggots in the cloacal region. Whether this condition resulted from gassing is not known at this time. Of 12 rattlesnakes gassed, three died, apparently from the effects of the gasoline. The remainder showed no ill effects, even after 4 months of confinement. Two adult male gopher frogs were still alive 10 days after treatment.

Apparently, the effects of gasoline on the lower vertebrates is influenced by several important variables. These include temperature, time of year, physical condition of the animal, and the immediate response of the animal to the presence of gasoline in its retreat.

### Simple Computer Techniques of Computer Mapping

Charles T. Traylor  
Department of Geology and Geography  
University of Alabama, University

The purpose of this paper is to focus attention on the simplicity of computer mapping, the equipment required, and the results of some of the existing computer mapping programs. By using existing computer programs, maps can be produced with a minimum of effort, generally the only requirement being that the data first be key punched into data cards. The completed map is produced by the computer output system. In a matter

of minutes the computer output system produces the completed map which may be immediately analyzed. The maps produced can be used as analytical research tools as well as for visual communication in the traditional sense.

Preparing data for use in computers is not too difficult. It generally consists of converting outlines, borders, data points and data values to an X and Y coordinate system of reference. This is usually accomplished manually by overlaying a grid over a base map of the area to be mapped. However, this may be accomplished by a mechanical device known as a digitizer. Other information, that generally has to be fed into the computer, would be the control instructions such as map size, type of map, and the selection or rejection of any options the program might contain.

Computers are capable of producing three basic types of maps, the contour map, the conformant map and the proximal map. (SYMAP - Introductory Manual for Synagraphic Computer Mapping (Version 4, Feb 1967), Harard Laboratory of Computer Graphics.) Contour maps are of three general types: first is the traditional topographic map showing elevation the second is the mathematical model showing a statistical surface; the third type is represented by an oblique view which gives the impression of three dimensions. In all three types, the computer interpolates between data points and produces the contour map.

Conformant maps are of areas already delimited by some type of boundary. The area may be a state, county, city, census tract or any other bounded area. This type of map requires that the limits of the zones be indicated by the locations of the vertices of the boundary so they can be reproduced in the approximate correct shape by the computer. Shading may be used to give some quantitative value to each area.

The proximal map is a special type of map in that the locations of data points are given and the computer establishes the zone boundaries based on the distance between neighboring points. This type of map is generally used for qualitative mapping.

The equipment required for producing computer maps varies according to the type of map to be produced and the program being used. However there are three output devices that are generally used for producing maps, these being the printer, the point-line plotter, and the cathode ray tube.

The printer is used to a great extent because it is common to most computer systems, and it can use existing programs with little or no modification. The map is produced by printing letters and symbols on a line by line basis.

The point-line plotter is capable of drawing straight lines between given points, thus delimiting zones and areas of the same shape as the true areas. Curved lines may be drawn by using short straight-line segments. Some programs allow the shading of areas by lines and dots. The point-line plotter may also be used to produce oblique views of three dimensional models.

The cathode ray tube output is similar to the point-line plotter except that lines are drawn electronically instead of mechanically. It is the fastest of the three output devices.

This latter method, the cathode ray tube display, was used in a study by the Geography Department of the University of Alabama. (Aspects of Frequency of Visitation and Tributary Area of McFarland Mall, Department of Geology and Geography, University of Alabama, unpublished report). Major objectives of the study were to map the residence location of consumers in a major regional shopping center, and to correlate residence with variables taken from a questionnaire. A total of seventy-seven maps were produced showing the spatial characteristics of each variable. The variables included age groups, frequency of visits, stores visited, products bought, and time of visits. Such a comprehensive set of maps would have taken many man hours to produce. The computer produced the maps in less than one hour.

Mapping by computer has many advantages. Not only is it faster than manual methods but some maps can be generated that would be impractical to produce by manual methods. These maps are often used as analytical tools to quickly solve problems; variables may be introduced experimentally to check results. They may be used for visual communications of statistics or theories. Also they may be used to keep records of spatially oriented data such as air pollution or population dynamics. The speed with which different variables may be introduced encourages experimentation and more complete analysis than might otherwise be the case.

### PHYSICS AND MATHEMATICS

Theory of Intrinsically Strain Broadened Line Shapes for Magnetic Resonance Absorption Within the Non-Kramers Doublets of  $\text{Al}_2\text{O}_3:\text{Fe}^{2+}$  and  $\text{MgO}:\text{Fe}^{2+}$

C. M. Bowden and H. C. Meyer  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

A theoretical model is presented for magnetic resonance absorption for transitions within the non-Kramers doublets of  $\text{Al}_2\text{O}_3:\text{Fe}^{2+}$  and  $\text{MgO}:\text{Fe}^{2+}$ . The asymmetric broadening of the absorption distribution is interpreted on the basis of the spin-lattice coupling. By introducing uniaxial stress boundary conditions into the model, the results of uniaxial stress experiments are predicted.

### Correlation of Light Pulse and Electrical Pulse Amplitudes in a Proportional Counter

I. A. Brezovich and E. L. Robinson  
Physics Department  
University of Alabama, Birmingham

Continuing earlier studies of light pulses in proportional counter



(A.J.P.L. Policarpo, M.A.F. Alves, and C.A.N. Conde. 1967. Nucl. Inst. and Meth. 55: 105; M.A.F. Alves and A.J.P.L. Policarpo. 1967. Nucl. Inst. and Meth. 57: 321.) a study of the relationship between the amplitudes of the electrical pulses and their associated light pulses in proportiona counters is made by means of two parameter spectra recorded with a Nuclea Data System 50/50 multiparameter analyzer. The spectra will be presented and their significance relative to proportionality of the amplitudes of the pulse will be discussed.

#### Swingby Maneuvers About the Natural Satellites

Jack W. Crenshaw  
Northrop Corporation  
Huntsville, Alabama

It is now well known that the use of gravity-assist, or swingby, maneuvers offers significant advantages in the design of interplanetary transfer trajectories. Several papers have been published in recent years which show that swingby maneuvers about intermediate planets can be used to reduce fuel requirements, entry velocity, flight time, or combination of the three.

In a similar manner, trajectories can be designed which utilize swingby maneuvers about the natural satellites in the solar system to attain various ends. One such maneuver is the "capture" maneuver, in which a swingby about a natural satellite is used to reduce the planetocentric velocity of a space probe. In some cases, the velocity change during the maneuver is sufficient to change the planetocentric orbit of the probe from an hyperbolic to an elliptic one, thus causing the probe to become captured by the planet.

An analogous maneuver is the "slingshot" maneuver, in which the swingby increases the planetocentric velocity of the probe. The slingshot and capture maneuvers are, of course, closely related, but are not equivalent because of the different constraints usually imposed on inbound and outbound orbits.

In this paper, both the capture and slingshot maneuvers are examined analytically using the patch-conic approximation, and expressions giving upper limits for the velocity changes that can be imparted during such maneuvers are given. Using these expressions, the feasibility of using the natural satellite swingby maneuver is examined for several missions and various planet/satellite pairs.

#### Time Sharing in the Teaching of Physical Science

Army Daniel, Jr.  
Alabama A. & M. University  
Normal, Alabama

For three years now we have been involved in an experiment in learning. This adventure has taken place in 14 colleges and universities in

11 southern and southeastern states, in predominately Negro schools. Our Project, called "The Thirteen College Curriculum Program" was born out of the necessity to make some changes in the first two years of the education of these students as they embarked upon their college careers. For two years I have given the Academy a running score on these 1,400 students (the number has now grown to 5,400). This paper is a report on one segment paraphrased in the area of physical science--the introduction of the computer on a TIME SHARING basis.

The mere physical presence of an additional tool in the laboratory was sufficient to arouse some of the students. But when the terminal became operative, the results were extremely positive. Approximately 50% of the 50 students have very keen interests in the "new handle" on physical science parameters.

The addition of the time sharing system has proven to be an excellent tool for instruction, relatively inexpensive to operate for short periods (can become an expensive operation if unchecked), and has turned on some of the students that had not been reached up to that point. The language is simple enough for a student of "average" intelligence can learn the language in a couple of hours, some sooner. The beginner's BASIC has caught on and student response has convinced me that it does enhance the teaching of physical science.

## CO<sub>2</sub> Lasers

George J. Dezenberg  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

The great interest in carbon dioxide lasers stems from their versatility, efficiency, and ease of construction. The  $10^{-5}$  m wavelength of the CO<sub>2</sub> laser is in an atmospheric transmission window. At  $10^{-5}$  m the ratio of the spontaneous transition probability to the stimulated transition probability is small. This enables the CO<sub>2</sub> laser to be used as an amplifier as well as an oscillator. The CO<sub>2</sub> laser can be operated with a continuous or a pulsed discharge. When a continuous discharge is used the laser can be Q-switched and mode locked. With a continuous discharge 60 to 80 watts of output power per meter of discharge length at 15 to 20% efficiency can be obtained with a conventional axial flow CO<sub>2</sub> laser. The continuous output power of CO<sub>2</sub> lasers can be greatly enhanced by using transverse gas flow. Commercial transverse flow lasers are available that have an output of 1,000 watts per meter of discharge. High peak powers can be obtained with CO<sub>2</sub> lasers by using a pulsed discharge. Pulses of 50 J at 20 megawatts and 10% efficiency have been obtained with a 3.5-meter-long, 5-cm-bore CO<sub>2</sub> laser operating at 1/10 atmosphere.

On The Structure of the Wind Profile to 25 KM and the  
Geographic Distribution of Wind Models

Oskar M. Essenwanger  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

The individual wind speed profile has been represented by three terms of the Fourier Series. The coefficients were interrelated, and thus a reduction to one characteristic coefficient with a set of constants was possible. The constants vary with season and geographic location. From the mathematical representation of the wind speed profile eight groups of profile families have been derived. These groups show typical tropical, subtropical, and midlatitude wind profiles, called so after their dominant appearance at the respective station.

In the subtropical region (Montgomery, Alabama) the typical wind speed profile with one maximum at the jetstream level (10-14 km) predominates in all seasons except summer. It occurs in winter and spring in 90% of all cases, with 75% in fall.

The midlatitudes (Chateauroux, France) also display a typical speed profile with one single maximum, which is somewhat lower than the subtropical profile. Thus the frequency of occurrence varies between this midlatitude and the subtropical profile, the latter dominant in summer and about equally likely in spring and fall. The two types comprise 70% of the total wind speed profiles in the midlatitudes. In winter only the midlatitude type prevails at a low 30% of the total time.

The tropical profile (Albrook, Canal Zone) typically exhibits undulating lower wind speed in the troposphere and an increasing speed from 18 towards 25 km. This type can be observed in about 40% of the time in the tropics in spring, summer, and fall, but also appears 50% of the time in the polar region in winter. The dominant speed profile in the tropics in winter provides two wind maxima, one at the jetstream level and a second one with similar speeds at the top level of the profile, 25 km. This is the cutoff altitude of the ascents in our study. The altitude of the maximum speed is higher but does reflect into the wind speed profile below only by creating the 25 km maximum.

In the polar region (Thule, Greenland) the single maximum midlatitude profile prevails in all other seasons but winter with 40 - 50% frequency of occurrence and a peak of 65% in fall. The high 25% of profiles with very little wind throughout the entire range from surface through 25 km in summer at Thule (Greenland) is noteworthy.

Sets of profiles with double maxima (in the troposphere and above 20 km) appear scattered over all geographic locations and seasons to make up the remaining numbers.

## Abstracts

### The Pure Vectorial Method Its Power and Elegance: Some Examples

Rafael M. Fiterre  
Department of Mathematics  
University of Alabama, Huntsville

During the last year there appeared, in the teaching of mathematics, a tendency to consider the vector as an abstraction defined as a triple ordinate number and the Vectorial Calculus as a chapter of the Linear Algebra. This trend is justified and legitimate when we consider abstract spaces of  $n$  dimensions; however, in the fields of vectorial mechanics and solid geometry and their applications, considering the vector as a geometric entity is, in my opinion, more reasonable and useful. The aim of this paper is to emphasize that a vector is a geometric entity in itself and should not be considered merely as a triple number.

### The Significance of the Phase Factor in Experimental Measurements of Fermi Surfaces in Metals

Howard J. Foster  
Alabama A & M University, Normal, Alabama  
and  
Redstone Arsenal, Alabama

A review is given of the theoretical basis and physical significance of the phase factors  $\phi$  in experimental measurements of the Fermi surface in metals. The theoretical description of the phase factor for spherical Fermi surfaces is compared with experimental measurements in zone refined potassium crystals of different purity. It is clearly established that the phase correction factor is a function of the resonance number from geometrical resonance in the magneto-acoustic effect and tends to do a limiting value of 0.375, as predicted in the free electron approximation, for  $q\lambda \gg 1$ . (The propagation vector  $q = \frac{2\pi}{\lambda}$ , where  $\lambda$  is the ultrasound wavelength.) The limiting value of  $0.324 < \phi < 0.404$  was found in the study of a "pure" potassium crystal, compared to a departure in this limiting value of about 53% (smaller) for an impure crystal. The rather large departure is attributed to electron-impurity interactions and leaves some uncertainty as to whether the corresponding smaller Fermi diameter from the magneto-acoustic effect is real or apparent.

### A Transfer Curriculum in Mathematics for Two Year Colleges

W. L. Furman  
Spring Hill College  
Spring Hill, Alabama

The Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America has prepared a report with the above title as an aid to the articulation of two-year and four-year programs

in mathematics. Students in engineering, physical science and mathematics prepared to begin calculus can complete the calculus sequence in two years. Courses preparatory for calculus requiring one semester or two semesters are recommended for those needing such, but more time is required to complete the calculus sequence. Sufficient mathematics can be taught students in biological, management and social sciences and in the elementary teacher training program to meet their needs. Programs can be arranged to meet the needs of students with different mathematical backgrounds and requirements.

#### Scintillation Properties of Liquid Nitrogen and Liquid Oxygen

H. H. Knox, A. H. Werkheiser, and T. G. Miller  
Redstone Arsenal, Alabama

The scintillation properties of liquid nitrogen and liquid oxygen have been investigated separately. Liquid nitrogen and liquid oxygen produced measurable scintillations when irradiated by beta rays, gamma rays, and neutrons. In addition, liquid oxygen responds weakly to alpha particles. The scintillations produced could not be resolved into specific energy peaks in either case. The self-absorption coefficients of both liquid nitrogen and liquid oxygen were determined using a  $^{90}\text{Sr}$  beta ray source.

#### The Care-Oriented Medical Record

Emmanuel Mesel  
Information Sciences and Pediatrics  
University of Alabama, Birmingham

The University of Alabama in Birmingham automated patient record goes one step beyond the Weed "problem-oriented" system in being "care-oriented". That is to say it provides a mechanism to insure that the physician and other members of the health team have the most complete information available each time a patient is seen and plans for his treatment and care are formulated. To provide a strong incentive to the patient-care team to adopt the seemingly radical changes in creating a machine-reviewable medical record, we have devised a system which will convert a computer produced "Worksheet" into a "Daily Summary". The brief notations made by members of the health-care team upon the Worksheet will be entered into the computer by a medical record technician, and the Worksheet will be converted by computer programs into a Daily Summary. This solution uses the computer to do the things it does best, such as handling large volumes of data and shuffling them under program-logic control and makes the machine the servant of the health-care team rather than its master. It will also free the members of the professional staff to do the things they do best, such as diagnosis, planning and supervision of effective therapy.

## Abstracts

### A Technique for Measuring Light Output and Decay Time vs. Wavelength for Scintillators

T. G. Miller, R. G. Polk and A. H. Werkheiser  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

A technique has been developed for measuring light output and decay time vs. wavelength for scintillators. The technique uses a monochromator with the scintillator placed at the entrance slit. Stilbene was used as the scintillator and its pulse shape discrimination properties were employed to investigate differences in decay times for incident gamma rays and neutrons.

### Cusp Phenomena in Associated Production of Elementary Particles

J. Edwin Rush, Jr.  
University of Alabama, Huntsville

The appearance of a kinematic cusp in a partial-wave amplitude due to the opening of a new channel is demonstrated, using K-matrix formalism. This is applied to the S-wave amplitude of channels  $\pi N$ ,  $\Lambda K$ , and  $\Sigma K$  with isospin  $1/2$ , where the cusp should appear in  $\Lambda K$  due to the  $\Sigma K$  threshold. The possibility of a particularly strong cusp effect in the total cross-section for  $\pi^- p \rightarrow \Lambda K^0$  has been suggested (C. Van Dyck, R. Blumenthal, S. Frankel, V. Highland, J. Nagy, T. Sloan, M. Takats, W. Wales, and R. Werbeck. 1969. Physical Rev. Letters 23; 50) on the basis of total cross-section data. A study of the S-wave computed by the author shows, instead, that a fit to the data of Van Dyck, *et al.*, would require an extremely unusual behavior of the K-matrix in conjunction with the  $\Sigma K$  threshold. This is not to be expected since the cusp effect is unrelated to the behavior of the K-matrix, but depends simply on the density-of-states factor in the partial wave amplitude. (Supported in part by NASA Grant No. NGR-01-002-063)

### A Relation Between Integrals of Hermite Polynomials of Different Orders

Romas A. Shatas and John D. Stettler  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

Hermite polynomials are solutions to the Hermite differential equation  $dy^2/dx^2 - 2x dy/dx + 2ny = 0$  which is often encountered in mathematical physics. For example, normalized and weighted Hermite polynomials are eigenfunctions of the Hamiltonian describing a vibrating molecule (John D. Stettler and Romas A. Shatas. 1969. Bond stretch in diatomic vibrators induced by rotational-vibrational interaction. Internat. J. Quantum Chemistry, 3S(2): 635) in the harmonic approximation. The usual procedure in obtaining polynomials of a given order is to employ either the generating function or one of the differential recurrence relations



(N. N. Lebedev. 1965. Special functions and their applications. Revised English ed., Prentice-Hall). We have derived a relation between integral of polynomials of different orders of the form

$$\int_{-\infty}^{\infty} \exp(-x^2/2) H_n(x) dx = 2^k (n-1) (n-3) \dots (n-2k+1) \int_{-\infty}^{\infty} \exp(-x^2/2) H_{2n-k}(x) dx$$

$k \leq n/2$ . Notably, this expression is already weighted by the function  $\exp(-x^2/2)$  and it is useful in relating spatial integrals of eigenfunctions belonging to different eigenstates of the Schrödinger partial differential equation for the molecular vibration problem.

#### Temperature Effects on Spectral Position, Width and Intensity of Zero-Phonon Lines

J. D. Stettler, R. J. Chynoweth, R. A. Shatas, and H. R. Wittmann  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

Sharp lines observed in the spectra of electronic transitions in impurities and defect centers in crystals have been interpreted as "zero-phonon lines" and explained as the optical analog of the Mössbauer effect, the recoilless emission of  $\gamma$ -rays by nuclei in solids. The spectral position, half-width and intensity of these zero-phonon lines have been noted to vary with temperature. These variations have been explained in terms of linear and quadratic coupling between the lattice vibrations and the radiating electron. Simple theoretical expressions are obtained under the assumptions that the coupling is independent of the lattice vibrational frequencies and that the lattice vibrations exhibit no dispersion. Theoretical predictions developed under these simplifying assumptions are reviewed and compared with experimental data obtained on the  $14\,764\text{ cm}^{-1}$  zero-phonon line seen (R. J. Chynoweth, J. D. Stettler, H. R. Wittmann, and R. A. Shatas. 1970. Bull. Amer. Phys. Soc. 15: 207) in single crystals of  $\text{CaF}_2$  heat treated to contain excess Ca. The limitations imposed by the previous assumptions will be demonstrated and the improvement of the model used in theory discussed.

#### Meteorological Parameters for Arbitrary and Natural Time Periods

Dorathy A. Stewart  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

Presently available climatological information is based upon atmospheric behavior during arbitrary periods which are invariant from year to year. An arbitrary time base is unrealistic because it does not coincide with the period between meteorological changes from season to season. This is especially true in the high-latitude stratosphere where the change from winter to summer conditions is often quite abrupt and may occur any time from mid-January to late March.

## Abstracts

A study of relationships among various meteorological parameters during natural periods has been made in the Aerophysics Branch. The records from three high-latitude stations were examined to determine the time of spring and fall reversal in stratospheric circulation for each year in the period for which we have computed conventional statistics. Some of the differences between the conventional and the more natural relationships are discussed.

### Computers in Physics Teaching

Guenter Schwarz

CRICISAM and Florida State University  
Tallahassee, Florida

CRICISAM, The Center for Research in College Instruction of Science and Mathematics, was formed through a cooperative effort of many universities and colleges in the southeastern United States. It provides a center for the investigation, development, and dissemination of new materials and techniques of collegiate instruction in the various fields of science and mathematics. Financial support has come in part from participating institutions, however the major sources of support so far have been contracts and grants. Currently, 17 institutions are members, and each year a few more are added. The eventual success of CRICISAM will depend on a strong membership organization willing to support the effort both intellectually and financially.

Since CRICISAM began operations in April 1966, with Florida State University as host institution, it has devoted much of its attention to the impact of computers on college instruction. One of the most successful projects has been the development, under an NSF grant, of a textbook: "Calculus - A Computer-Oriented Presentation". This text represents a substantial rethinking of how to teach calculus in the age of the computer. During 1969-70, it was used experimentally in about 50 institutions with almost 1400 students; a substantially increased use is predicted for the next academic year. Another area in which work has been done is that of Computer Assisted Instruction (CAI) with special emphasis on physics.

In this paper the whole area of computer use in physics instruction will be surveyed. The discussion will deal with the use of the computer as an aid to problem solving (computational mode), its use as a patient and uncomplaining tutor (CAI), the application of the computer to laboratory use, such as simulation of experiments and their extension to situations not normally available to students, the development of computer animated films and their unusual and often dramatic impacts. Examples for the different uses will be shown.

An Undergraduate Laboratory Experiment on the  
Interaction of Gamma Rays with Matter

J. T. Tarvin, A. J. Mims and E. L. Robinson  
Physics Departments  
Samford University, and University of Alabama, Birmingham

An undergraduate laboratory experiment has been developed to demonstrate the dependence on atomic number of the interaction of gamma rays with matter by Compton scattering and photoelectric effect. Gamma rays of various energy are detected by scintillators of various effective atomic numbers: NaI(Te), CsI(Na), KI(Te), and  $\text{CaF}_2(\text{Eu})$  scintillators are used. The results are compared with theory.

The Point Transformation Method

Norman M. Witriol  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

The point transformation method is derived, and its advantages discussed. An example of the power inherent in the method is demonstrated by applying it to the isolated two body hard core problem. For "s" states, the transformed Hamiltonian is the free body one; the effects of the hard core being completely contained in the transformation.

INDUSTRY AND ECONOMICS

Effect of Quota Plans on Milk Supplies in Alabama

Lowell E. Wilson  
Department of Agricultural Economics  
Auburn University

Quota systems to control milk supplies have been in effect in the State for many years. The State Milk Control Board supervises the administration of quota plans. Two quota plans are now being used to determine producer base--the "plant usage" and the "alternate plan". Differences in provisions of the two plans cause different supply responses of producers shipping milk under each. The "alternate plan," first put into effect in Alabama in the early 1960's, helps the dairyman protect the size of his quota from year to year and in this respect is superior to the "plant usage" plan. However, continued use of the present "alternate plan" may endanger the adequacy of milk supply in the State.

SCIENCE EDUCATION

Description of a First Attempt to Provide  
Individualized Science Instruction Using Systems Concepts

Neil P. Clark and Floretta G. Clark  
Columbus College and Clubview Elementary School  
Columbus, Georgia

This instructional approach was designed to provide individualized science instruction for elementary school children. This particular study involved a class of 27 third grade children at Clubview Elementary School, Columbus, Georgia. The purpose of this was to produce feedback from the students, the teacher, and the instructional materials to aid in improving the instructional procedure.

The instructional materials included instruments designed to provide information concerning student's background knowledge as well as frequent feedback concerning individual student progress in the achievement of behavioral objectives. An attempt was made to guide students in their learning activities based on feedback from these instruments as well as teacher observations and discussions with students. Provision was made for student self-evaluation.

Students studied certain basic concepts in astronomy. Information concerning objectives was provided by cassette tape recorders and in writing. Students studied independently and in small groups using the teacher as a guide and a resource person. A variety of media was used. Student reaction to this approach was enthusiastic. Learning did occur as indicated by student response and scores on the Posttest, the mean of which was 95 (out of a possible 100). Further experimental work is planned.

Cardboard Carpentry's Role in Preparing Elementary  
Teachers to Teach Science

Hollis C. Fenn  
Florence State University  
Florence, Alabama

Elementary teachers in a Cooperative College-School Science summer workshop and Pre-service students worked with a new Elementary Science Study unit called Cardboard Carpentry. They used laminated cardboard, which is three layers thick and comes in very large sheets, to make a number of ordinary objects such as tables, chairs, and toys. This material is strong, inexpensive, and easy to work with simple tools. Not only did this activity encourage creativity, but it also developed skills such as using tools, measuring, estimating, and decorating. Small groups of 4th grade boys were used in a microteaching class for in-service students and they didn't want to stop work. We feel that this unit can help to make our schools livable.

Electricity and Earth Science Workshops for Elementary  
and Junior High Science Teachers

Mary E. Hafling  
West End High School  
Birmingham, Alabama

The increasing amount of science added to school curricula since Sputnik I has required many teachers to teach science whose formal training in science is zero, limited, or out-of-date. Colleges and universities do not offer courses for graduate credit that meet the needs of these teachers. Such courses are greatly needed and the teachers deserve graduate credit.

The Birmingham School System held three workshops for elementary and ninth grade science teachers financed by the federal government under Title I: two in Electricity, June 1968 and 1969; one in Earth Science, June 1969. Each was for four hours each of five days. The school of each participant was given a shoe-box kit of laboratory apparatus.

Evidence is abundant that the goals of the workshops were largely met: for the participants to gain knowledge of the subject-matter, develop ability to use laboratory apparatus and audio-visual aids, be encouraged to conduct laboratory classes, develop a sense of security in teaching the subject.

The "Cardboard Computer" as a Tool in Science Education

Ernest D. Riggsby  
Columbus College  
Columbus, Georgia

This paper is another in a series of reports of work completed in a science education project which was begun at Troy State University, later moved to Auburn University, and finally located at Columbus College. Articles and short papers related to the project have appeared in *Newsreel*, *Alabama School Journal*, *AEMA Newsletter* and *J. Ala. Acad. Sci.* It is anticipated that the project (Synergistics in Science Education Project) will continue to function for at least two more years or until the major experimental aspects are concluded.

Educational technology, with its attendant hardware, software, and "instructional engineering" is currently making a strong impact upon science education. Students, long exposed to the 16 mm motion picture projector, and now and then the 35 mm filmstrip projector, almost suddenly found themselves surrounded by a full range of A-V hardware and a good variety of teaching machines, computers, and a maze of the other realia of instructional technology. The major problems attendant to the drastic increase in numbers and kinds of instructional hardware and "gadgets" were not centered around students but around teachers. The variety of equipment and the effective use of such equipment poses a prime concern of teacher education and re-education. This paper identifies and describes the use of an element of that instructional media which

## Abstracts

we have dubbed "cardboard computer." The devices are variously made of cardboard, paper, wood, plastic, and metal. Functions of the devices range from complex computation to simple information presentation. A common design is similar to the ordinary slide-rule. Other variations include: slide-wheel, movable scale, and *rolling* (scroll) device.

Two aspects of the use of "cardboard computers" in science education were examined in this study: (1) time, and (2) cognitive retention. Two null hypothesis were statistically tested: (1) There will be no difference between the amount of time required to teach a concept in physical science, through the use of a "cardboard computer," and the amount of time required to teach the same concept through the use of the textbook-handbook-laboratory-manual approach, and (2) Students will show no difference in cognitive retention when taught a concept through the use of the "cardboard computer" as compared with the usual textbook-handbook-laboratory-manual method.

Results of the study: The first hypothesis was rejected. There was a difference in the amount of time required to teach the concept. The smaller amount of time, 28% less time, was required in the use of the "cardboard computer". The second hypothesis was accepted. There was no significant difference between the groups, with respect to cognitive retention. This would tend to argue for the use of the devices as time-savers with some assurance that the element of cognitive retention would not be significantly less than ordinarily expected.

### Seek-It Three Years Later

William B. Shell  
Department of Secondary Education  
Auburn University, Auburn, Alabama

Seek-It is an acronym for self-directed educational experiences kit. It utilizes the systems approach to developing units of study that can be used by the student on a self-directed basis. Briefly, a Seek-It is composed of a student guide and a teacher guide. The student guide contains a list of the learnable ideas about a particular topic in a content field. These ideas are written in terms of student behavior or performance. The pretest and posttest items are derived from the behavioral objectives. Each lesson in the student guide of the Seek-It is developed on a multi level-multi media basis and contains self-evaluations, recycling instructions and suggested quest activities.

These Seek-Its are developed by science education students at Auburn University and are being field tested at Bullock County High School and Union Springs Elementary School, Union Springs, Alabama, under the direction of Mrs. Mary Carlson and Mrs. Sara Ogletree. Seek-Its have been received quite enthusiastically by both the teachers and students who are involved in the program. In light of the field testing results, the Seek-Its will be revised and will be made available to other schools that would like to participate in this individual self-directed program.



Sanitation Guidelines for Pecan Processing Plants

Johnny Mac Smith  
Troy State University  
Troy, Alabama

In this study of pecan processing sanitation, reference is made to the Food and Drug Administration. Also referred to is a series called Plant Evaluation System (PEV) issued by the Food and Drug Administration. The study was conducted with the cooperation of Mr. Jimmy Gatlin, Plant Manager, Funsten Pecan, Division of Pet Incorporated, Andalusia, Alabama, and was coordinated through the Troy State University Sanitary Science Program. The plant was observed for a period of eight weeks in which inspections, cleaning, and follow-up works were carried out. The object of this study was to establish guidelines for general sanitation of the plant. The result was a 22 page booklet of guidelines.

The techniques employed in cleaning and sanitation by the plant were the same as previously used -- steam cleaning and sanitation by chlorinated water; however, these were used to a greater extent in previously neglected areas. Upon initiation of these changes and programs, biological examinations were conducted by the plant laboratory on trouble areas. Results of these tests showed no contamination present in any of the areas tested. Shortly after, the plant was subjected to an inspection by the Food and Drug Administration in which approximately 50 samples were taken to be examined for coliform contamination. Results showed no contamination in any of the areas tested.

SOCIAL SCIENCES

Three Stars and a Wreath, Alabama Style

John W. Bloomer  
Birmingham News  
Birmingham, Alabama

When sectional emotions and antagonism boiled over into a military conflict, setting the fires that burned for four years as the American Civil War, the North and the South looked immediately to the professional soldiers of a small and widely scattered federal army for leadership. But these were minuscule in numbers for the task of creating and leading the huge armies that sprang into being on both sides.

Out of Southern law offices, off plantations, out of business offices poured Southern patriots in the greatest volunteer response the nation has known to a military challenge. Of the thousands of volunteers who swarmed to the Confederate battle flag in Alabama, 26 survived the hazards of the battle line to advance through the ranks before the conflict ended to wear the wreath and three stars of a general officer. Nine Alabamians who had attended the United States Military Academy, many of whom had no professional experience, joined their volunteer comrades as general officers. These 35 Alabamians helped to write some of the most exciting chapters of battlefield valor in that monumental conflict, the American Civil War.

## Abstracts

### A Study of the Effect of Exposure to Material While Asleep and While Falling Asleep in the Learning of a Foreign Language

John T. Carter  
Samford University  
Birmingham, Alabama

This paper summarizes some of the attempts that have been made to induce learning in subjects while asleep, and some of the claims of success in this area. While companies marketing material designed for sleep learning report uniformly positive results, few scientific studies have been made of its effectiveness. Mass instruction in the English language is reported to be conducted very successfully in the Soviet Union. A recent project at Samford University attempted to test the possibility of sleep learning by students on an individual basis. The study yielded evidence that under some conditions sleep listening might be a helpful supplement to conscious study.

### Simon Bernard and the Board of Fortifications

Virgil S. Davis  
Mobile College  
Mobile, Alabama

The fall of Washington during the War of 1812 demonstrated the need for more adequate national defenses. The citizen-soldier had not functioned well in defense of the national capital and no system of coastal defenses existed. From the resulting concern, Congress authorized the President to employ a "skillful assistant" for the Corps of Engineers. This assistant was a Frenchman, Simon Bernard, aide de camp to Napoleon. Though the appointment of a foreigner cost the Corps some of its most valuable personnel, it proved a wise choice. Bernard provided the basic plan for a system of fortifications extending from the Sabine River in the Southwest across the Gulf Coast and up the Eastern Seaboard.

This system included an elaborate defense for Mobile Bay including recommendations for two forts which were to be exceeded in size by only Fort Monroe, Virginia, and Fort Delaware. Those recommendations were backed by extensive surveys and keen observations concerning the future development of the Alabama-Tombigbee River Valleys and their relation to the defense of New Orleans and Pensacola.

Bernard further suggested that the Tombigbee and Tennessee Rivers would be connected by a canal, making the Port of Mobile the outlet for the commerce of a vast area. He resigned in 1831 and returned to France where he became aide de camp to Louis Philippe and, later, Secretary of War.

The Battle of Mobile Bay, March 14, 1780

Joseph Delaney  
Vanderbilt University  
Nashville, Tennessee

In April, 1779, Spain joined France and the American colonies in the American Revolution against England. The Spanish objective was to defeat the English along the Mississippi River and the Gulf of Mexico and drive the British from mainland North America. Spain would then control the entrance to the Gulf of Mexico and be able to protect her interest in the West Indies.

In 1779, Bernardo de Galvez, the Spanish commander at New Orleans, attacked and defeated the British at Manchac, Baton Rouge, and Natchez. The British were driven from the Mississippi River area and Galvez now turned his attention to the English strongholds of Mobile and Pensacola in West Florida. Assisted by troops from Havana and a contingent from New Orleans, he surrounded the English fortress, Fort Charlotte, at Mobile and for 14 days the defenders were able to hold out. But Captain Elias Durnford, the commander of the fort, realized that the reinforcements from the British post at Pensacola would not arrive on time. He tried to delay the capitulation, but on March 14, 1780, he surrendered after a siege of 14 days. The British soldiers were conducted to another fort and released, under the condition that they would not fight against Spain for 18 months.

In 1781, Galvez captured Pensacola and the British flag was removed from West Florida. Galvez was appointed governor of Louisiana and Mobile and placed in charge of all Spanish operations in America. His accomplishments were not undone until 1819 when the United States received Florida from Spain.

Somatology - History and Present Status

Helen I. Douty  
Department of Consumer Affairs  
Auburn University, Auburn, Alabama

By means of an historic overview of anthropological emphases and concepts, and by citation of general approaches in the study of the human body in terms of centers of investigation and leading researches and theorists, a context and rationale for a specialized area of study - somatology - have been evolved. A redefinition of the concept is proposed. From a narrow definition of the study of body measurements, it is proposed that somatology be used to connote 1) the study of the human body, especially measurement of gross body characteristics and 2) study of the significance of the body habitus for the individual and for social interaction. On the basis of research at Auburn, instruments and methodology for such study have been developed. The method is termed "graphic somatometry", a photographic method of abstracting body shape, size, and contour from total body characteristics. Body build and posture scales and a physical inventory have been developed to quantify observations thus making possible new types of inquiry.

## Abstracts

### An Early History of the Industrial City of Anniston, Alabama, 1872-1879

J. P. Hagerty, Jr.  
Lawson State Junior College  
Birmingham, Alabama

Anniston, Alabama, the county seat of Calhoun County, is located in the mineral region of northeastern Alabama. Because of the minerals and especially the iron ore deposits, Samuel Noble was attracted to this area in 1869 to investigate the possibilities of beginning an iron ore industry. In 1872, he was able to interest Daniel Tyler and his son, Alfred, to come to the area which resulted in the organization of an iron producing industry known as the Woodstock Iron Company. As a result of this company a little community was formed and was incorporated under the laws of the Probate Court of Calhoun County in 1873.

During the years 1873 to 1879, the Woodstock Iron Company continued to grow and the reputation of the high quality of its iron ore deposits spread throughout the United States. The Nobles and the Tylers controlled the town by an absolute proprietorship which lasted until 1879. At this time the town was officially incorporated by the laws of Alabama, but this action simply gave the proprietors more political power with which to rule their town.

From 1879 to 1883, the proprietors laid the foundation of "the Model City." They increased the industries of the city by adding a large cotton mill and a railroad car wheel works. During the same period they improved the town by building an electric light plant, a water system, parks, churches, and homes for their employees. They also paved the streets and planted trees.

In July of 1883, the proprietors opened the town to other industries. The opening was followed by Anniston's first boom which lasted until the latter part of 1885. Anniston's industries and businesses expanded greatly, but in the latter part of 1885, a business lull struck the city. This lull was principally caused by the failure of New York financiers who were marketing the iron and its products to the rest of the world.

During the latter part of 1886 plans were made to remedy this situation by offering more land to the public which attracted northern industries to Anniston. As a result, the Anniston City Land Company was formed in 1887 which conducted a great land sale. The people in Anniston went wild and a frenzy of speculation possessed them. Many new industries and businesses came to Anniston and the population was greatly increased. This land sale and real estate boom was much greater than the boom of 1883. While the second boom was at its height, Samuel Noble died. The people were momentarily stunned by the death of their leader, but they soon recovered and continued the building of the city.

Gerhard Ritter (1888-1967) and the Problem of Militarism

William Harvey Maehl  
Auburn University  
Auburn, Alabama

Gerhard Ritter of Freiburg University was a basically conservative, nationalist historian. A foe of Nazism, who chose to remain at his post, he never lost his love of country. He deplored the libel that Germany's past had only been a prolegomenon to Nazism and toiled to dissociate the fatherland from it. In his studies of enlightened leaders in German history, Ritter discovered patterns of acceptable political conduct for the present. In his *Staatskunst und Kriegshandwerk* he defined the essence of true statesmanship and argued that "militarism" is a potentially universal phenomenon, more frequent in a democratic than an aristocratic age. Among the major leaders in the nation's history, only Ludendorff and Hitler were real "militarists". Fritz Fischer notwithstanding, chancellor Bethmann-Hollweg was no militarist, and it is rank distortion to pretend that there was continuity of war aims from Bethmann through Ludendorff to Hitler.

Two factors, above all others, explain the rise of German militarism the peculiar relationship of the civil government to the army and the nation, which was a derivative of Germany's strictly continental-type evolution; and the legacy of the French Revolution, which was to politicize and militarize the masses. France, not Germany, was thus the first to stress the militant potentiality of the state.

The Lynching of Jack Turner:  
A Political Assassination in Alabama, 1882

Gerald L. Roush  
Auburn University  
Auburn, Alabama

Alabama was redeemed from radical Republican rule and reconstruction by the Democratic victory in the state election of 1874 following a campaign involving fraud, violence, and intimidation. The end of reconstruction did not mark the end of violence in Alabama politics, however. The Democratic and Conservative party resorted to violent means when necessary to retain control. An example of such activity was the lynching of Jack Turner in 1882. Supposedly an execution for plotting a Black insurrection against the white population of Choctaw County, the death of Jack Turner indicates a political motivation and his lynching had political repercussions. The ultimate effect of the assassination was dampened, however, by events outside Choctaw County and beyond Alabama.

## Abstracts

### Samford's Transition to the January Term

David M. Vess and Jack Duncan  
Samford University  
Birmingham, Alabama

Samford University is among the first of the nation's universities to adopt a 4-1-4 calendar and create a separate January Term. To date, the majority of the institutions engaging in this type of calendar alteration have been small liberal arts colleges with relatively simple organization structures when compared to full universities with their complex of professional schools. Ever since mid-1967, the administrators, faculty and students of Samford have been working together to overcome these structural complications and develop a calendar tailored to meet accreditation requirements, student interests and the University's diverse academic needs.

Through the use of committee assignments and participative decision-making, the Samford Plan has progressed from an abstract idea with unknown feasibility to an extremely important segment of the academic year. Numerous unique programs such as travel-study and off-campus exercises, independent study, interdisciplinary seminars and limited regular courses, primarily offered on a pass/fail basis, form the nucleus of the Inter-Term.

Upon the completion of the first January Term, an extensive evaluation was completed via the circulation of a questionnaire to participating students and faculty. Both groups exhibited exceptionally favorable impressions on all the key issues such as the pass/fail system, educational philosophy involvement and intellectual challenge. In conclusion, it seems safe to say that Samford students and faculty alike have come to look upon the Inter-Term as an opportunity to exert their individualism and to do those things which are not feasible during the regular semester.

### Orthography and Reading

Frederick L. Westover  
University of Alabama  
University

To many reading specialists, it appears that the primary task in learning to read is one of decoding spelling into word recognition. Reading involves much more than decoding, but if this is the primary step it appears that learning to read should be facilitated if we were to eliminate spelling irregularities by the adoption of a simple consistent orthography with a one to one relationship between graphemes and phonemes.

The more common systems of modified orthographies that have been proposed and used to simplify spelling and ease the problem of learning to read are presented and illustrated in a table. From these systems a new one is derived that may have some merit in simplification.



The question is then raised whether any modified orthography has any advantage in the teaching of reading. Research reports on this question are reported and the conclusion drawn that so far no one orthography appears to be significantly better than any other but that the ability of the teacher appears to make an important difference in learning to read.

Further research is needed on the comparative advantages, if any, on the use of modified orthographies.

### Brief History of Alabama Agriculture

J. H. Yeager

Department of Agricultural Economics

Auburn University, Auburn, Alabama

The history of Alabama agriculture is one of change: the rise and decline of cotton, the disappearance of workstock as a source of power, growth of land values and capital investments in farms, substitution of capital for labor, recent rapid expansion of soybean acreage and production, and phenomenal development of the livestock and poultry industries. Because the number of people involved directly in producing farm products has declined, the average layman concludes that agriculture is of lesser importance in the economy of the State today than in yesteryears. Research studies have indicated that \$1.00 of farm income generates more than \$3.00 in total income; however, \$1.00 in nonfarm income generates only about \$1.50 in total income.

Cotton was a major crop in early history of Alabama. Maximum acreage of 3,801,000 was reached in 1914. Generally, acreage of cotton has declined since the 1930's. In 1969, soybeans were produced on a greater acreage than cotton or corn.

From a largely subsistence basis of livestock and poultry production in early years, Alabama's livestock economy has changed dramatically. In 1940, livestock and poultry accounted for only 30% of Alabama's cash farm receipts; in 1968 they accounted for 70%.

In 1860, Alabama had 55,000 farms. The number increased to a peak of 273,000 in 1935 and has since declined. In the late 1970's, it is likely that the number of farms may decline to about the same level as in 1860. In spite of fewer farms and the decline in farm population, Alabama agriculture continues as a dynamic industry that produces food, fiber and other products for a growing state, national, and world population.

## Abstracts

### MEDICAL SCIENCES

#### A Study of the Effects of Chloroquine As an Inhibitor of *in vitro* Mitochondrial Respiration

Phil C. Benton and K. L. Yielding  
Laboratory of Molecular Biology  
University of Alabama, Birmingham

Clinical findings which indicate that long term injection of chloroquine induces muscle weakness and hepatic damage prompted a more intensive study of the inhibition of mitochondrial NADH oxidation by chloroquine which had been observed previously in this laboratory (Mushinski and Yielding, *Arth. and Rheum*; 5, 178 (1962)). Chloroquine was shown to be an effective reversible inhibitor of respiration by sonicated or frozen mitochondria with exogenous NADH as observed by both spectrometric means and oxygen uptake. Chloroquine did not have any effect on respiration when succinate was the exogenous substrate. The inhibition by chloroquine was overcome by added cytochrome C in liver but not in preparations from heart.

The kinetics of chloroquine and pentothal inhibition were compared since chloroquine appeared to act at the same NADH-dehydrogenase-CoQ step as do the barbiturates. However, the kinetics were quite different for the 2 drugs and chloroquine was a much more potent inhibitor. The effects of a number of chloroquine analogs were also examined to determine the structural requirements for drug action.

The results of this work suggest the possibility that some of the biological effects of chloroquine and related drugs could occur through specific inhibition of mitochondrial processes. This may be particularly pertinent to the antiparasitic effects if mitochondrial function should prove critical to parasite survival. (Supported by U. S. Army Grant DA 49-193-1770-3040)

#### Studies of Left Ventricular Pressure and Diameter in Dogs

Marshall N. Boone, Jr.  
Department of Physiology and Biophysics  
University of Alabama, Birmingham

The relationship between the energy of contraction of the left ventricle and the initial fiber length was called "the Law of the Heart" by Starling. Left ventricular pressure is commonly used as an indication of the energy or force of contraction. Since initial fiber length cannot be directly measured in a functioning heart, changes in left ventricular end diastolic pressure are usually related to changes in fiber length. However, a more precise relationship exists between fiber length and ventricular volume or diameter.

Studies were done on dogs using a diameter gauge designed by Pieper which continuously measured changes in internal transverse diameter and

pressure in the left ventricle. Measurements were also made of the aortic pressure and flow and the electrocardiogram. Diameter changes were related to volume changes by calibration against the aortic flow and by volume calculations assuming a spherical ventricle.

Pressure-diameter loops were used to study the relationship between ventricular pressure and diameter changes. The area of these loops provides a measure of the external cardiac work. Vagal stimulation decreased the external cardiac work below control values. Epinephrine and norepinephrine (1.5  $\mu\text{g/K}$ ) increased the force of contraction by positive inotropic effects on the heart thereby increasing cardiac output and decreasing end systolic volume.

#### Effect of Neuraminidase on the Properties of Salivary Proteins

J. Martin Briscoe, Jr., Kenneth M. Pruitt, and Robert C. Caldwell  
Institute of Dental Research and Laboratory of Molecular Biology  
University of Alabama Medical Center, Birmingham

The matrix of dental plaque has long been considered to be composed to an appreciable extent of salivary proteins. Previous studies have shown that the enzymatic cleavage of sialic acid, a glycoprotein sugar component, results in a reduction of characteristic saliva viscosity and the formation of a precipitate. It has also been found that the plaque matrix is practically devoid of sialic acid, which suggests that the bacterial enzyme neuraminidase may be a key factor in the mechanism of plaque formation.

Since salivary proteins may play an important role in plaque formation, we have undertaken studies to determine whether the neuraminidase cleavage of sialic acid produces any changes in the affinity of salivary proteins for the surfaces of hydroxylapatite. Such studies are important since the deposition of modified salivary proteins on the tooth surface may be related to plaque formation and subsequent dental caries.

We have found that the addition of neuraminidase to submandibular saliva produces a large increase in turbidity within a few minutes, suggesting an increase in the extent of aggregation of the salivary proteins. Adsorption studies showed that the pretreatment of hydroxylapatite with crystalline neuraminidase produced no modification in the adsorption isotherm for salivary proteins. Samples of hydroxylapatite were exposed to saliva solutions which had been incubated with neuraminidase. Again there was no modification in the adsorption isotherm for salivary proteins.

Although neuraminidase has been shown to alter the structure of salivary proteins, it appears to have no effect on the affinity of these salivary proteins for the surfaces of hydroxylapatite.

## Abstracts

Lloyd Noland - Sanitarian, Surgeon, Hospital Administrator

Emmett B. Carmichael  
University of Alabama Medical Center  
Birmingham

Dr. Lloyd Noland was born on July 25, 1880 at Gordonville, Virginia. He was awarded the M.D. degree from Baltimore Medical College in 1903. Following a year of internship he was invited to accompany the Isthmian Canal Zone Commission to Panama. He was appointed executive officer to Dr. William Crawford Gorgas and was chief surgeon of the Colon Hospital from 1905 to 1913. He became superintendent of the T.C.I. Health Department in 1913 and convinced the company that it was necessary to build a permanent hospital to care for the employees. The Employee's Hospital was built during World War I, and was opened in November 1919 with Dr. Noland as the superintendent. He was chief surgeon and was a regular contributor to the medical journals. His professional connections were numerous, which included fellowship in both the American College of Surgeons, and the Southern Surgical Association. He was honored by being elected president of both the Jefferson County Medical Society and the Medical Association of the State of Alabama. He was quite active in committee work in the American Medical Association.

Dr. Noland was active in local civic affairs and was a member of the Kiwanis Club, the Birmingham Country Club and the Roebuck Country Club. Dr. Noland married Margaret Gillick November 7, 1907; they had no children. He passed away on November 27, 1949.

Robert Ernest Noble

Emmett B. Carmichael  
University of Alabama Medical Center  
Birmingham

Robert Ernest Noble was born November 5, 1870 in Rome, Georgia. The Noble family ancestors were the DeGrenobles of Normandy. Robert received his early education in Rome and Anniston, Alabama. He graduated from the Alabama Polytechnic Institute in 1890 with the M.S. degree. He was assistant State chemist in Alabama in 1892, and assistant State chemist in North Carolina in 1893. He was an instructor in chemistry at A.P.I. from 1893 to 1895 and also served as assistant State chemist. He enrolled in the College of Physicians and Surgeons, Columbia University, in 1895, and received the M.D. degree on June 7, 1899. He entered the U.S. Army as acting assistant surgeon in 1900, and was ordered to the Philippines with the rank of 1st lieutenant. He served at several posts and graduated from the Army Medical School, Washington, D.C. in 1904.

Dr. Noble served with Dr. William Crawford Gorgas, as a member of the Isthmian Canal Zone Commission in Panama. He served as a member of sanitary commission at the Rand Mines, Transvaal, South Africa, and at Vera Cruz, Mexico. He served the War Department in France October 25, 1918 and returned to the U.S.A. on August 3, 1919.

Dr. Noble was decorated with the Distinguished Service Medal and was made a Commander of the French Government in 1919. Following his retirement, he took an active part in various civic affairs in Anniston. He rose to the rank of Major General of the Army.

Dr. Noble married Ella, daughter of Professor Nathaniel Thomas and Ella Virginia (Allemong) Lupton. Dr. Noble died on September 18, 1956.

Joseph Augustus Le Prince

Emmett B. Carmichael  
University of Alabama Medical Center  
Birmingham

Joseph Augustus Le Prince was born August 8, 1875, in Leeds, England. He came to the United States when he was six years old. After graduating at Sach's Collegiate Institute, New York City in 1894, he enrolled in the School of Engineering, Columbia University. He graduated with the C.E. degree on June 8, 1898, and the M.A. degree in 1899. His Masters Thesis was entitled "Deer Mining." Following about two years of construction and survey work, he joined Dr. William Crawford Gorgas in Cuba in 1900 to help rid Havana of the *Aedes aegypti* mosquitos that were transmitting yellow fever. He was appointed chief sanitary officer and determined the average flight range of the mosquito, which helped in the control of the pest.

Le Prince joined the Isthmian Canal Zone Commission to Panama in 1904. He was the chief sanitary inspector and was in charge of the field men. After the Panama Canal was opened, Mr. Le Prince was assigned as senior sanitary engineer in charge of Malarial investigation, U.S. public Health Service, with headquarters at Memphis, which had been a fever-stricken city for many years. He retired in 1939 after 40 years with the Public Health Service. He continued an active life until a short time before his death on February 9, 1956.

Preparation of Plant Cell Components by Zonal Centrifugation

Brenda R. Chafin, Martha K. Dagg, and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Subcellular components from homogenates of collard plant cells were separated into zones on sucrose density gradients in the B-XIV zonal centrifuge rotor. The separations were made in one hr at a rotor speed of 30,000 rpm on discontinuous density sucrose gradients which were buffered either with Tris, sodium-potassium phosphate or with potassium phosphate alone. The results showed that at least six zones of material could be recovered. With some small variations, these zones of material were found banded in 31%, 38%, 40%, 42.5% and 52%. The small differences in banding density were observed when different buffer systems were used. Four of the zones, 38%, 40%, 42.5%,

## Abstracts

and 45% contained chloroplasts. The material in the 52% zone was presumably perixosomes while the zone in 31% was unidentified.

### Alterations in the Properties of Glutamate Dehydrogenase by Modification of Amino Groups with Trinitrobenzenesulfonic Acid

Charles E. Clark and K. Lemone Yielding  
Laboratory of Molecular Biology  
University of Alabama, Birmingham

The reaction of glutamate dehydrogenase (GDH) with 2,4,6-trinitrobenzenesulfonic acid (TNBS) resulted in changes in catalytic, regulatory, and physical properties of this enzyme. The modification of amino groups with TNBS was stopped by separating unreacted TNBS on a Sephadex G-25 column, such that one mole of TNBS was bound per mole of 53,500 molecular weight chain of GDH. Modification to this extent resulted in a stable preparation which had lost only 25% of its catalytic activity. The  $K_m$  values of the modified enzyme for the substrates  $\alpha$ -ketoglutarate, ammonium chloride, and reduced nicotinamide adenine dinucleotide (NADH) were not significantly different from the native enzyme. The TNBS-modified enzyme was less responsive to the "allosteric" inhibitor, guanosine triphosphate (GTP), but lost none of its responsiveness to the "allosteric" stimulator, adenosine diphosphate (ADP). Also, ADP was capable of antagonizing GTP inhibition of both the modified and native enzymes. Ultracentrifugation, in the presence of  $1.0 \times 10^{-4}$  M NADH, showed two peaks for the treated enzyme, while the native enzyme had only one. Previously, ADP has been shown to reaggregate reagent-induced disaggregation of GDH, but was unable to cause reaggregation of the two peaks of the TNBS-modified enzyme. In most cases of GDH disaggregation, the disaggregated form has been shown to be less stable than the higher molecular weight form. In contrast, the TNBS-modified enzyme was disaggregated but was more stable to heat than the native enzyme. These experiments have produced a stable, modified species of the enzyme which displays changes in its regulatory properties so that extensive studies may be undertaken. (Supported by U.S. PHS Grant AM 08274)

### Sample Capacity of High Resolution Discontinuous Sucrose Density Gradients

George B. Cline  
Department of Biology  
University of Alabama, Birmingham

It has been possible to significantly improve the resolution of separation of various subcellular components from both animal and plant cells by employing discontinuous density gradients made from sucrose solutions. Whereas the usual continuous density gradient permits separation of only 2 to 3 subcellular components, discontinuous density gradients permit simultaneous separation of 8 or 9 components.



The zones of material are stopped in the gradient at the diffusion interfaces of any two adjacent sucrose solutions. By carefully adjusting the volume and density of a series of solutions of increasing density, separate subcellular particles can be stopped and recovered from each interface. Most of the larger subcellular particles are banded isopycally during the separation. With a small sample mass, the resolution attained with discontinuous density gradients is related directly to the slope of the gradient and indirectly to the mass of sample. Discontinuous density gradients in theory should have no sample capacity in the flat part of the gradient. However, due to mixing of interfaces between any two adjacent solution being pumped into the rotor, a shallow gradient is produced. Since the rationale for using discontinuous gradients is to stop particles on the diffusion interfaces, one is not overly concerned with capacity of the shallow areas. Capacity of the interfaces is limited by the volume of the interface as well as the gradient across that interface. Zones that sediment far out into the gradient normally pass through several interfaces and it appears that passing through interfaces causes a zone to be reshaped and kept in a narrow band. This repeated reshaping helps to overcome one of the problems of zone widening by radial dilution.

Preparation of Large Sheets of Fibrin  
by Centrifugation in the  
B-XIV Zonal Rotor

George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Fibrin, the serum protein component relied upon for blood clot formation, can be easily isolated from plasma in the B-XIV zonal centrifuge rotor. Particle-free plasma from citrate or oxalate containing blood is made to 0.03 M with  $\text{CaCl}_2$  and mixed in the cold for several hours. This mixture is loaded into the zonal rotor and centrifuged overnight at 30,000 rpm. The sheet of fibrin is peeled from the edge of the rotor after the fibrin-depleted solution is emptied from the rotor. The thickness of the sheet is related to the starting volume of the plasma. The sheets are elastic and are composed of randomly oriented strands of fibrin which have been stuck together by gravitational force. These sheets can be stored in distilled water or in saline but will swell to approximately twice their thickness. They can also be dried and rehydrated with little loss of elasticity. Fibrin sheets or strips may be of use where bleeding or other surface trauma are to be contained. The sheets might also be used as substrate for tissue cell culture.

## Abstracts

### Isolation of Myxovirus-like Particles from Acute Phase Infectious Hepatitis Plasma

George B. Cline  
Department of Biology  
University of Alabama, Birmingham

F. Deinhardt and A.W. Holmes  
Rush-Presbyterian-St. Luke's and University of Illinois Med. Centers  
Chicago, Illinois

W.W. Harris and F.L. Ball  
Molecular Anatomy Program, Oak Ridge National Laboratory  
Oak Ridge, Tennessee

A paramyxovirus-like particle has been isolated from the sera of humans and marmosets which have been diagnosed as having infectious hepatitis. This virus-like particle has a diameter range of 1100 to 1400 nm and contains an internal core of about 18 nm. Its membranous coat does not appear to contain surface structures. The particle has been isolated in cesium chloride density gradients using the Spinco #30 angle head rotor. The intact infectious particle bands isopycnicly at a density of 1.21 to 1.22 while damaged and noninfectious particles band at about 1.32 g/cc. The 1.21 zone of particles is occasionally contaminated with 20 to 25 nm particles which are presumed to be Australia antigen. Purified density 1.21 material from humans is highly infectious in marmosets. The apparent fragility of the virus-like particle results in the particle's being presumably mechanically degraded during pelleting in centrifuge tubes. There are also suggestions of breakdown of the particles in cesium chloride but not in sucrose. Large scale isolation and complete biophysical characterization of these particles is now underway.

### Characterization of Human Kidney Cell Components in S- $\rho$ (Sedimentation-Density) Coordinates

Betty Cox, K.L. Yielding and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Human kidney cell components have been partially characterized in S- $\rho$  coordinates. This procedure which utilized first rate-zonal followed by isopycnic banding centrifugation yields a profile for human kidney which is constant with respect to number, position, and size of peaks. It has been shown that this technique is suitable for recovering small amounts of added virus and therefore represents a reasonable approach in the search for viral-like particles present in pathogenic tissue.

Effect of Statolon on LDH Virus Multiplication in Mice

Charles G. Crispens, Jr.  
Department of Biology  
University of Alabama, Birmingham

Statolon, known to be an interferon inducer, was found effective in inhibiting the multiplication of the lactate dehydrogenase (LDH) virus in C57BL/Fg mice. Under the conditions tested, optimal protection was achieved by a single intraperitoneal injection (4.5 mg/20- to 22-g mouse) given 6 to 12 hr prior to the challenge. When various dilutions of the LDH virus were compared, there were marked and progressive differences between the corresponding plasma titers of statolon-treated and normal mice at 24 hr. It would appear, then, that the protective effect of statolon is a function of the quantity of virus introduced. The above observations are interpreted as evidence which is consistent with the view that interferon plays an important role in the abrupt suppression of the initial high rate of LDH virus replication. (Supported by PHS Grant 5 R01 CA05742-06 from the National Cancer Institute, and by a grant from the Medical Research Council of Canada)

A Maternal Effect on the Teratogenicity  
of Azauridine in Mice

C.P. Dagg  
Department of Biology  
University of Alabama, Birmingham

6-Azauridine (AzUR) interferes with *de novo* pyrimidine synthesis by inhibiting orotidylic decarboxylase. The injection of AzUR, intraperitoneally, into mice on the tenth day of pregnancy produced polydactylism in the embryos. SJL and C57BL/Ks embryos were equally highly sensitive to AzUR. Strain C57BL/10 embryos were intermediate, and strains 129/Dg and BALB/C were relatively resistant. The existence of three separate levels of response suggests that at least two pairs of genes were responsible for the differences between the most and the least sensitive strains.

Reciprocal crosses were made between SJL and BALB/C mice. Hybrid embryos were intermediate in sensitivity to the two homozygous parental type embryos, which indicates that some of the genes controlling sensitivity were operating in the embryos. The two types of hybrid embryos differed in frequency of polydactylism which indicates that maternal genes also played a role in determining the level of response. In addition, compared with each other, the frequency of malformations in the hybrids was shifted toward the paternal rather than the maternal strain, a patriclinous maternal effect.

The sex of the embryos was compared with the presence or absence of malformations to determine whether the patriclinous effect was due to genetic factors on the Y chromosome. The results did not support

this conclusion. Also, there was no conclusive evidence that a maternal cytoplasmic factor in the egg had influenced the results. Untreated embryos of the parental and the hybrid types were examined on the tenth day of pregnancy, and on the basis of size differences, it is tentatively proposed that the patriclinous effect is due, at least in part, to differences in stage of development at the time of exposure to AzUR.

Large Scale Isolation of Chloroplasts  
in the K-11 Zonal Ultracentrifuge

Martha K. Dagg and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Special zonal centrifuge rotors have been designed for the simultaneous isolation, concentration, and purification of viruses from large volumes of solution. One such large capacity zonal rotor, the K-11, was used in this study for the isolation of two types of chloroplasts from homogenates of collard plant leaf. Efficiency of recovery of the two types of chloroplasts was assessed as a function of sample flow-through rate.

Eighty to 90% recovery was obtained at flow-through rates of 15 liters per hr (Q) at a rotor speed of 4,000 rpm. Variable recoveries from experiment to experiment probably reflect difficulty in establishing a good flow pattern within the rotor at this low speed. For the same percentage recovery at 8,000 rpm, however, the sample must be pumped through at a Q of 45. In these studies, a 3000 ml density gradient was used. This gradient was made by pumping into the rotor at rest the following solutions: 750 ml of 30%, 1000 ml of 41%, 750 ml of 47%, and 500 ml of 60%. The sample was homogenized in 25% sucrose and was suspended in 5 to 7 liters. The chloroplasts trapped by the rotor were sedimented to their isopycnic banding densities of approximately 39% and 45.5% sucrose. A total of about 2.5 g of chloroplasts was obtained from 100 g of starting material. Work is in progress on metabolic activity of these chloroplasts and on the large scale preparation of each type of particle.

The Inhibition of Spontaneous Motility in  
the *In Vitro* Gastric Mucosa of Frogs

Cathy Dickinson, J. Marshall Garrett and R.L. Shoemaker  
Department of Medicine, Physiology and Biophysics  
University of Alabama Medical Center, Birmingham

Because of the potential use of diazepam (Valium<sup>R</sup>) in disorders of the digestive tract, this study was undertaken to determine its effect on gastrointestinal motility. Isolated longitudinal strips of frog stomachs were used in an *in vitro* chamber; the motility patterns

were recorded using a force-displacement force transducer. The tissue was bathed in an amphibian Ringer solution bubbling 95% O<sub>2</sub> - 5% CO<sub>2</sub>. Diazepam,  $1.8 \times 10^{-3}M$ , produced a marked reduction in frequency and force of smooth muscle contractions. The motility pattern was restored by removing the drug from the reservoir (changing to a solution not containing the drug). The site of action is unknown but this study suggests that the drug acts directly on smooth muscle as well as the previously reported tranquilizing action on the central nervous system. (Supported by Alabama Division, American Cancer Society)

#### Formation of the Alabama Academy of Honor

Eleanor L. Downey and Albert E. Casey  
Memorial Institute of Pathology and Departments of Pathology  
Baptist Medical Centers (Montclair and Princeton) and  
University of Alabama, Birmingham

At this time it is proper to record steps which were taken to form the Alabama Academy of Honor while memories and documents are still available.

The original idea for the Academy was by our fellow member, Emmett Bryan Carmichael, B.A., M.S., Ph.D., President of Alabama Academy of Science, 1930-31, a native Missourian, formerly Assistant Dean at the University of Alabama Medical School and School of Dentistry and until retirement, Professor and Chairman of the Department of Biochemistry, University of Alabama. During 1965, the authors were privileged to be shown a copy of the Missouri Academy Squire by Dr. Carmichael who believed a similar organization was needed to recognize distinguished living Alabamians who had made significant contributions to our State or to our Nation. The first letter, dated March 10, 1965, was to the Honorable George C. Wallace, Governor of Alabama. Mr. Malcolm Bethea, State Representative of Jefferson County, sponsored House Bill 40, 1965, Second Session, and it became Act No. 15. Through the efforts of Governor Wallace and Mr. Bethea, the Act was passed by the Alabama House of Representatives on October 22, 1965, and on the same day was guided through the Senate by Senator Lawrence Dumas, Jr., of Jefferson County. The Act was finalized on October 29, 1965, by Governor George C. Wallace.

A committee of two from each congressional district was to be appointed by the Governor. This nominating committee was first appointed on August 21, 1968, by the Honorable Albert P. Brewer, Governor of Alabama, and consisted of the following with Dr. Carmichael as Chairman: First Congressional District - Henri Aldridge and William Herin; Second Congressional District - Robert Inman and Jake Merrill; Third Congressional District - Dr. Harry Philpott and C.J. Coley; Fourth Congressional District - Walter Graham and Carl C. Morgan; Fifth Congressional District - Herbert Goldstein and Col. Paul Robinson; Sixth Congressional District - Emmett B. Carmichael and Duard LeGrand; Seventh Congressional District - A. P. Reich and Mrs. James Britain; Eighth Congressional District - Mrs. Houston Glover and Howell Heflin; Secretary - Mr. Robert Inman.

## Abstracts

The first persons elected to the Alabama Academy of Honor were: Winton M. Blount, Albert Preston Brewer, Paul W. Bryant, James E. Folsom, A.G. Gaston, Lister Hill, Thomas H. Moorer, John Patterson, Frank A. Rose, Frank P. Samford, Bertha Smolian, John Sparkman, Werner Von Braun, and George C. Wallace. Alabama is fortunate in having an organization in the State such as this, and the authors are pleased to record the efforts of a fellow member and scientist in its inception.

### The Effect of the DNA Repair Inhibitors Chloroquine and Caffeine on the Response of Tumors Treated with Either an Alkylating Agent or with X-Rays

David Gaudin and K. Lemone Yielding  
Laboratory of Molecular Biology  
University of Alabama, Birmingham

The DNA repair inhibitors chloroquine and caffeine markedly enhance the response of cytoxan resistant plasmacytomas and melanomas to alkylating agents and X-rays without exerting a comparable increase in toxicity to the hematopoietic system. The DNA repair inhibitors had an effect on tumor growth only when used in conjunction with either an alkylating agent or with X-rays, and were without effect when used alone. Similar results were observed with a sensitive line of plasmacytomas from which the resistant tumor line was derived.

### Blood Lactic Acid Disappearance and Oxygen Debt Payment Following Exercise in Humans

M.G. Gerin  
Department of Physiology and Biophysics  
University of Alabama, Birmingham

The relationship between the kinetics of the oxygen debt payment and the kinetics of arterial blood lactic acid (LA) removal has been investigated in 10 human subjects 20-25 years old following three experimental procedures: short duration, light (40% of  $V_{O_2}$  max.) and heavy (80% of  $V_{O_2}$  max.) exercise; prolonged, intermittent exercise, alternating heavy exercise periods, and rest recovery periods, and heavy exercise periods and light exercise recovery periods. The rate constants of the slow component of oxygen debt payment ( $k_2$ ) were computed as well as the rate constants of LA removal ( $k_{AL}$ ). Performing a light exercise during the recovery from a severe one strongly enhances the removal of LA: the value of  $k_{AL}$  increases from  $0.0747 \pm 0.0207 \text{ min}^{-1}$  (corresponding to a mean half-time of 9 min. 16 sec.) for rest recoveries to  $0.1283 \pm 0.0275 \text{ min}^{-1}$  (corresponding to a mean half-time of 5 min. 24 sec.) for exercise recoveries; this change is highly significant ( $p < 0.01$ ). Simultaneously, no significant changes of  $k_2$  are observed ( $p > 0.4$ ). The values of  $k_{AL}$  have been correlated with the corresponding values of  $k_2$  in a total of 73 recoveries analyzed; contrary to classical theory on oxygen debt payment, no relation between both rate constants is observed ( $r = 0.02$ ).



Correlations of Inorganic Phosphorus with Hospital Discharge Diagnoses

Fred E. Gilbert, Albert E. Casey and Eleanor L. Downey

Memorial Institute of Pathology and the Departments of Pathology  
Birmingham Baptist Hospitals and Medical College of Alabama, Birmingham

Multiphasic screening of 28 blood chemistries in an admission metabolic profile was performed on 8,320 consecutive male hospital patients. Interrelations of IP with the discharge diagnoses from these patients were determined utilizing Chi-square tests. Significant correlations ( $P = 0.01 - \text{sig.}$ ) existed for high IP with malignant hypertension, cirrhosis, renal failure, healing fractures, diabetic ketosis, and non-anemic blood dyscrasia; low IP with gram negative septicemia, pneumonitis, emphysema with chronic bronchitis, pathologic fractures, osteoarthritis, diverticulosis, hernia, hemorrhoids, acute coronary, CHF, benign hypertension, psychoses, neuroses, peptic ulcer, CNS, benign tumors, BPH, cancer (soft tissue), alcoholism, gout, diabetes mellitus, and hyperinsulinism. No correlations existed for thyroidism, schizophrenia, rheumatic heart disease, lymphoma, hepatitis, osteoporosis, Paget's disease, or TB. The use of multiphasic screening with automation and computerization affords an opportunity to study metabolic pathology in a manner not hitherto possible. Such data allows insight into the "metabolic set" or "metabolic display" of the diseased condition and a continuing appreciation of Sir Archibald Garrod's concept of chemical individuality.

Manometric Characteristics of the Opossum Gastroesophageal Sphincter

D.H. Godwin, N.R. Falkenberry, R.L. Shoemaker, and J.M. Garrett  
VA Hospital and University of Alabama Medical Center, Birmingham

This study describes the physiological characteristics of the gastroesophageal junction (GEJ) in the opossum as defined by 15 manometric and 3 cine-manometric studies in 5 tranquil (diazepam, intraperitoneal 2.5 mgm/Kg) opossums. Pressures were detected by using two infused open-tip (INF) and one 5 mm balloon (BAL) detectors. The mean length of the GEJ measured 2.8 cm by the INF and 3.5 cm by the BAL. Two peaks of pressure were detected as the INF and BAL were withdrawn from the stomach into the thoracic esophagus. Mean maximum pressure (end inspiration) of the distal peak was  $18.5 \pm 6.61$  and  $25 \pm 3.86$  cm  $H_2O$ , INF and BAL detectors. This peak corresponded to the distal end of the intra-abdominal esophagus and the upper peak to the level of the diaphragm confirmed by palpation of the balloon in 3 anesthetized opossums. Frequently a plateau of pressure was interposed between the two peaks and in addition 5 of the animals had double respiratory reversals. These are pressure characteristics of hiatal hernia in man. Swallowing produced relaxation (4.5 sec, mean) in the lower region, but contractions occurred throughout the intra-abdominal esophagus. Contractions were more prolonged distally (means 7.3 sec; 38 cm  $H_2O$  pressure) than proximally (means 4.1 sec; 35 cm  $H_2O$  pressure). These results indicate that a physiological

## Abstracts

sphincter exists in the distal portion of the intra-abdominal esophagus in the opossum. Therefore, the opossum gastroesophageal junction should make a good model for pharmacological and physiological studies.

### The Molecular Depression of the Aqueous Surface Tension by Various Organic Homologs in Solution

Alan Hisey  
University of Alabama, University

Fu and Wu (Proc. Soc. Exptl. Biol. Med., 27: 878(1939)) attempted to measure the molecular surface area of egg albumin by the use of Gibb's differential equation for the lowering of surface tension by substances in solution. Attempts in our laboratory to extend their work to other proteins revealed the lack of an adequate theoretical foundation for this subject. A grant-in-aid from the University of Alabama Research Committee enabled me to collect data from the literature for many organic substances and put the assembled data through the University Computer. The result is a general equation which is shown to be valid for the water soluble fatty acids, esters, and alcohols. The equation is  $F = aRT \ln g/1000 + aRTM/14$ , where "F" is the lowering of surface tension in dynes/cm, "a" is the surface excess in moles/cm<sup>2</sup>, "g"/1000 is the grams of solute per thousand grams of water, "M" is the molecular weight of the solute, and 14 is the molecular weight of the incremental methylene group. The value of "aRT" in any case is found from the slope of the linear midportion of the curve of "F" plotted against  $\ln "g"/1000$ .

### Histone Metabolism in Porcine Thyroids

Billie Sue Hulsey and R.H. Lindsay  
Departments of Pharmacology and Medicine  
University of Alabama Medical Center, and Nuclear Medicine Service  
VA Hospital, Birmingham

Histones have been postulated to be involved in the regulation of cell function by controlling the transcription of the genetic information contained in DNA. When bound to DNA, histone appears to act as a repressor of its template activity. Alterations in the DNA-histone complex can be produced by the incorporation of an acetate, phosphate, or methyl group into the histone protein. It has been suggested that some hormones may exert their regulatory effects by combining with histone or by affecting its acetylation, phosphorylation or methylation. The effect of TSH on acetylation, phosphorylation, and methylation of histones of porcine thyroid slices *in vitro* was studied to determine if the growth promoting action of the hormone was related to alterations in the repressor effects of histones. Slices of porcine thyroid were incubated with radioactive acetate-<sup>14</sup>C, phosphate-<sup>32</sup>P, and S-adenosyl methionine-<sup>14</sup>C, with and without TSH.

The histones were then extracted from the thyroid tissue and analyzed for protein and radioactivity. Results showed that the histones of porcine thyroid incorporated these three compounds, but there was no significant difference in the amount of incorporation with or without TSH. The presence of puromycin, an inhibitor of protein synthesis, had no effect on the incorporation of these compounds, showing uptake to be into pre-existing histones, not those being synthesized. These data indicate that TSH does not affect nucleic acid synthesis by alterations in histones.

#### TSH Stimulation of Pyrimidine Nucleotide Synthesis

R.H. Lindsay, Anna G. Cash, and J.B. Hill  
Departments of Pharmacology and Medicine  
University of Alabama, Birmingham, and Nuclear Medicine Service,  
V.A. Hospital

TSH stimulated the two step conversion of orotic acid to UMP increasing incorporation into RNA. The hormonal effect was not evident with low concentrations of orotic acid but was significant at 8  $\mu$ moles/vessel. The TSH effect was not altered by actinomycin D or puromycin. The action of TSH appeared to be mediated through an action on glucose metabolism since 2-deoxyglucose, an inhibitor of glucose utilization, abolished the hormonal stimulation. TSH, ribose, and glucose did not stimulate nucleotide formation at 0.67  $\mu$ moles of orotic acid/ml, when phosphorylated ribose was least likely to be rate limiting, but produced a marked stimulation at 2.7  $\mu$ moles/ml. Ribose produced the greatest stimulation and abolished the TSH effect. In contrast, the presence of glucose appeared to enhance the action of the hormone. Nucleotide formation was stimulated by inosine, another precursor of phosphorylated ribose, which also abolished the TSH effect. Stimulation of nucleotide formation was not increased by aspartate, succinate, or acetate indicating that energy production was probably not the primary stimulus for the hormonal increase in nucleotide synthesis. All of the data presented support the hypothesis that TSH stimulation of pyrimidine nucleotide and RNA synthesis is a consequence of a stimulation of glucose oxidation via the pentose pathway.

#### An Apparatus for Studying the Thermodilution Method for Making Ventricular Volume Measurements

R.A. Lloyd  
Department of Physiology and Biophysics  
University of Alabama, Birmingham

An apparatus is described in which a left ventricle with valves attached is hydraulically actuated by external compression and expansion, producing a circulation system analog with ventricular flow patterns that should closely resemble those in the living animal. It is expected to be a useful tool for studying the thermodilution method for measuring ventricular volume, particularly since the dynamic volume measurements can be checked against those made

## Abstracts

under static conditions. An initial set of temperature tracings produced by three thermistors in the ventricle and one in the aorta is shown.

### Lecithin Synthesis in the Tissues of the Chicken Embryo

John Monti, Maw Jian Cherng, Edwin Weller, and H. L. Spitzer  
Birmingham Southern College and University of Alabama Medical Center  
Birmingham

Experiments were carried out to determine the capacity of chick embryo tissues to synthesize lecithin, *de novo*, from choline. Choline-methyl-<sup>3</sup>H was injected I.V. into the circulatory system of the embryos. The embryos were sacrificed at 2, 6, 12, 24, and 48 hr periods. The lipid of brain, liver, and yolk sac membrane was extracted and brought to volume. Aliquots were taken for liquid scintillation counting and lipid phosphorous; the fat free dry weight for each tissue was also determined.

Results showed an incorporation of 50% of the administered isotope with about 5% being incorporated in the brain. This suggests that significant *de novo* lecithin synthesis is occurring in all tissues studied. The radioactivity in the brain and liver did not decrease with time indicating the absence of significant turnover. In contrast, the yolk sac membrane lost a significant amount of radioactivity with time. This latter observation suggests that the yolk sac membrane may play an active role in regulating the transfer of lecithin and/or its precursor. Furthermore, the data imply that the membrane actively breaks down yolk lecithin into its various components which are then taken up and transported via the circulatory system, as well as secreting *de novo* synthesized lecithin bound to circulating serum protein.

### Anatomy and Physiology of the Arterial System of the Boa Constrictor (*Constrictor constrictor*)

W.W. Nichols, J.E. Webster, and D.A. McDonald  
Department of Physiology & Biophysics  
University of Alabama, Birmingham

The physical equations relating pulsatile flow and pressure in mammals were fully worked out in 1955 by Womersley and McDonald. The precise application of these equations to the arterial system has been somewhat hampered by the fact that in a short or highly branching system considerable reflections of pressure waves occur from the periphery. Therefore, since the snake is a long, narrow animal with very few large branches arising from the aorta it was chosen as the experimental animal. The anatomy and physiology of the arterial system of five Boa Constrictors and one Anaconda were studied (weight: 3.8 - 6.5 Kg, and length: 1.5 - 2.5 m). A quick-setting resin was injected into the arterial system in order to

study the anatomical lay-out of the major branches. For comparative physiologic studies, ventricular pressure, central aortic pressure, aortic flow and the EKG were recorded. These events were similar to those recorded in the dog, except the pressures and flow were lower and the duration of the Q-T interval of the EKG was longer. Aortic pressures recorded at 15 cm intervals down the aorta were essentially the same as the central aortic pressure, indicating that reflected waves are damped out in the long aortic system of the snake. A Fourier analysis was performed by a digital computer on the pressure waves and the phase velocity of each harmonic component was calculated. The mean phase velocity for ten harmonics was 4.0 m/sec, which is approximately the same as the ascending aorta of the dog.

Study on Alteration in Catalytic and Regulatory Properties  
of Glutamate Dehydrogenase by Stoichiometric Binding  
With  $C^{14}$ -Labeled Methylmercuric Iodide

Mikio Nishida and K. L. Yielding  
Laboratory of Molecular Biology  
University of Alabama, Birmingham

Bovine liver glutamate dehydrogenase (GDH, E.C.1.4.1.3.) catalyzes a reaction of  $\alpha$ -ketoglutarate  $\rightleftharpoons$  glutamate. The rate of this reaction can be affected by various allosteric stimulators such as ADP, and inhibitors such as GTP, diethylstilbestrol (DES), and  $ZnCl_2$ . An organic mercurial of the type  $CH_3HgX$  also stimulates the catalytic activity, but reduces the effects of those allosteric reagents on the enzyme activity. The regulation of GDH by the allosteric compounds and the mercurial have been explained on the basis of conformational changes and the precise mechanisms are still under study, and provide the basis for the present experiments.

$C^{14}$ -labeled methyl mercuric iodide ( $CH_3HgI$ ) was synthesized and reacted with model amino acids and peptides, and showed binding only to sulfhydryl groups. Based on the enzyme molecular weight of 53,500, the binding of one mercurial per enzyme chain produced the maximum increase in catalytic activity, and caused no change in heat stability. Further binding of the mercurial resulted in loss of both catalytic activity and heat stability. This suggested that one specific SH group was clearly distinguished from the other SH groups in the enzyme. Inorganic mercuric compound ( $HgCl_2$ ) never showed the same effect. After the enzyme was treated with the mercurial and dialyzed to remove unreacted reagent, much higher concentrations of the allosteric effectors such as GTP, DES, and  $ZnCl_2$  were required in order to change the catalytic activity in the same manner as with the untreated enzyme. (Supported by NIH Grant AM08274)



Isolation of Peroxisomes from Rat Tissues in the B-XIV Zonal Rotor

Wayne L. Rickoll, W. Donald Fattig and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Microbodies (peroxisomes) are found in most animal and plant cells. The intracellular role of these organelles in mammalian cells is not well understood but they are known to play a role in energy dissipation in plant cells. Since it has been determined that plant peroxisomes can be banded isopycnicly in 52% (w/w) sucrose (density 1.247 g/cc), it was of interest to determine the behavior of peroxisomes from rat liver in high resolution sucrose density gradients. Separations were made from rat liver homogenate after being layered on a gradient made of 50 ml of 9%, 75 ml of 25%, 100 ml of 35%, 100 of 43%, 100 ml of 47%, 100 ml of 50% and an underlay of 60% sucrose. Results showed that at the end of a 35 minute separation at 30,000 rpm in the B-XIV zonal rotor peroxisomes were banded at 44.8% to 45.8% sucrose. At the end of two hours in the same discontinuous density gradient the particles were banded at from 45.6% to 46.8% sucrose (1.215 to 1.22 g/cc). Although the particles can be banded isopycnicly in sucrose, they share a common density with lysosomes and mitochondria. Although both plant and animal peroxisomes presumably both contain similar enzymes, no explanation can be given for their different isopycnic banding densities in sucrose.

Metabolism of  $\beta$ -Hydroxybutyrate in Subcellular Fractions  
of Developing Rat Brain

C.A. Robinson, Jr.  
Department of Biochemistry  
University of Alabama, Birmingham

Glucose is generally accepted as the sole source of substrates for energy metabolism in the mammalian brain. Recent studies by Owen have shown that during the last five days of a 40 day fast, human brain may derive as much as 75% of its energy requirement from  $\beta$ -hydroxybutyrate. Klee has shown that  $\beta$ -hydroxybutyrate dehydrogenase activity increases after birth. This activity reaches a peak sometime before weaning, then falls to the low adult level.

Our studies involved the isolation of subcellular fractions from the brains of rats 0, 5, 15, 20, 25 and 45 days of age. The brains were homogenized, layered over a gradient consisting of 5 ml each of 20%, 16%, 12%, 8% and 2% Ficoll and centrifuged at 90,000 X g for 1 hr. This procedure allowed the separation of 5 subcellular fractions. These fractions have been identified by Abdel-Latis as myelin, two layers of nerve-endings and 2 mitochondrial fractions. These fractions were assayed for NAD nucleosidase (3.2.2.5) which has been reported to be a nerve-ending marker,  $\beta$ -hydroxybutyrate dehydrogenase (1.1.1.30), acetoacetyl CoA transferase (2.8.3.5) and  $\beta$ -keto thiolase (2.3.1.9).



Activities of each of these enzymes were determined at each of the stated ages. Transferase and  $\beta$ -hydroxybutyrate dehydrogenase increased in activity up until the 20th day after birth, and then fell to the adult level at 45 days. In addition, the overall oxidation of 3-C<sup>14</sup> - $\beta$ -hydroxybutyrate was measured and this oxidation shown to follow this same pattern. Oxygen uptake studies with  $\beta$ -hydroxybutyrate as substrate also show a parallel pattern. Thio-lase remained fairly constant throughout development. The enzyme activities were localized primarily in the mitochondrial fractions.

Zonal Purification of Nuclear Polyhedrosis  
Virus of the Bollworm, *Heliothis zea*

Elaine M. Ryel and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

The nuclear polyhedral inclusion bodies (PIB) which are infectious in the cotton bollworm, *Heliothis zea*, can be efficiently isolated and purified in discontinuous sucrose density gradients in the B-XIV zonal centrifuge rotor. Differences in distribution of PIB's in the gradients depend on the method of preparation of the diseased insect. Although the major mass of PIB's band isopycnicly in sucrose from 55% to 56%, there can be other zones. The presence of such zones appears to be related to whether or not the insect mass was putrefied before attempting to isolate and purify the PIB's. When diseased insects are processed before they die of virus infection, PIB's can also be found at zones of 58.7% and 61% to 63% sucrose. In field material, the polyhedra are banded isopycnicly in 55% to 56% sucrose. It is suggested that putrefication by bacterial action somehow modifies the banding density of either the PIB's or PIB-cell component aggregates and leads to a single uniform zone of material. Bacteria, yeast, and protozoan spores and cells do not band with the polyhedral zone. This zonal procedure permits simultaneous isolation and purification of intact polyhedra with little or no loss of infectivity. The use of flexible discontinuous gradients makes possible a simple method for this purification of different banding PIB's.

A New Method for the Preparation of Zonal Fractions  
for Electron Microscopy

Richard B. Ryel and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

A procedure is described for preparing fractions obtained by zonal centrifugation for high resolution electron microscopy. Rat liver was homogenized in a Potter-Elvehjem homogenizer in ice cold 1.0% Glutaraldehyde buffered to pH 7.3 with 0.1M Sorensen's buffer. The homogenate was allowed to stand for 8 hr at 5C before fractionating

by zonal centrifugation on a discontinuous sucrose gradient designed for high resolution separation of rat liver subcellular components. Fractions were selected representing each banding density peak. Each selected fraction was diluted 1:1 with 0.1M Sorensen's buffer and pelleted at 1500 g for 2 hr. The supernate was carefully removed by vacuum suction. A 2% agar solution was prepared and maintained at 45 C from which 2 drops from a Pasteur pipette were placed on the pellet of each fraction. The pellet was mixed into the agar and a drop of the agar-pellet suspension placed on a glass slide at room temperature and allowed to stand for 1 minute. The solidified agar was then cut into 1 mm squares and placed in 1% osmium tetroxide for 2 hr followed by 2 hr in uranyl acetate. The agar blocks containing the fixed suspended pellets were then dehydrated and embedded in Araldite #205 by standard procedures. Electron micrographs of thin sections revealed virtually no loss of integrity of subcellular components normally encountered due to osmotic phenomena and shear forces from sucrose density gradients. The prefixation with glutaraldehyde had no apparent effect on the banding densities of the individual components when compared under identical separation conditions with unprefixated samples. This method makes possible a careful morphological analysis of cellular and subcellular components isolated by sucrose gradient zonal centrifugation.

## Isolation and Characterization of a Nuclear Polyhedral Inclusion Body from the Boll Weevil, *Anthonomus grandis*

Richard B. Ryel and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

A polyhedral inclusion body containing rod shaped virions is reported from the boll weevil, thus representing the first definitive virus particle of this type reported in the insect order *Coleoptera*. Boll weevil larvae and pupae were obtained from cotton bolls which had dropped to the ground in a field near Harpersville, Alabama. It was noted that several of the larvae were discolored and dead, suggesting pathogenic symptomology. The larvae were squashed between two rolling glass surfaces and filtered and washed with 0.1M Sorensen's buffer pH 7.2 containing  $7.5 \times 10^{-5}\%$  DOSSS through cheesecloth to eliminate the chitinous hulls and large debris. The filtered squashate was then pelleted at 10,000 g for 20 minutes and the supernate discarded. The pellet was then resuspended in 8.5% sucrose and fractionated on a discontinuous sucrose gradient. The percent sucrose (w/w) was determined as well as qualitative measurements of total RNA, DNA, and protein for each collected fraction.

For the purpose of morphological characterization the squashate from several field collected larvae was prefixed in glutaraldehyde and fractionated under identical separation conditions. The pellets from the fractions representing the banding density peaks were then fixed in 1% osmium tetroxide and stained with uranyl acetate and embedded for thin sectioning. Electron micrographs of the embedded

fraction representing the peak banding at 58.6% sucrose revealed classical polyhedral inclusion bodies containing rod shaped virions. The inclusion bodies ranged in size from  $0.4\mu$  to  $1.2\mu$  in diameter. The virion cores measured approximately  $26m\mu$  in width by  $200m\mu$  in length. The virion cores were surrounded by an external coat giving an overall dimension of  $60-65m\mu$  in width. A distinct ordered lattice structure appearing matrix is noted within the inclusion body. The lattices appear at approximately 64A intervals throughout the matrix. Investigations are presently underway to determine the activity of the virus through standard infectivity techniques.

The Excretion and Tissue Distribution of Radioactivity  
from Rubratoxin B in Male Mice

Karen L. Smith, Sheryl L. Leverett, and A. Wallace Hayes  
Department of Microbiology  
University of Alabama, University

Rubratoxin B, a metabolite of *Penicillium rubrum*, is toxic to most animal species. The potency of rubratoxin B as an acute toxin is illustrated by an  $LD_{50}$  value of 0.35 ml/kg when administered intraperitoneally to mice. Biochemical manifestations of the toxic action, which appear in the liver, persisted for short periods (72-96 hrs) following a single dose or a limited number of successive doses of rubratoxin B. It was therefore of interest to determine the patterns of excretion of radioactivity and the distribution of radioactivity in liver and other organs of mice during the 24-hr period following single administration of labeled rubratoxin B.

The rubratoxin B- $^{14}C$  used in these experiments was prepared by surface culture of *Penicillium rubrum* (NRRL A-11785) in liquid media containing labeled glucose as described by Hayes and Wilson (Applied Microbiol. 16:1163-1167, 1968). Specific activities of various preparations were in the range of  $2 \times 10^5$  cpm/mg. Male mice of the Swiss-Webster strain weighing 25-35 g were injected intraperitoneally with 0.05 mg labeled rubratoxin B and placed into metabolism cages which permitted quantitative, separate collection of urine and feces; expired  $CO_2$  was trapped in monoethanolamine: ethylene glycol monomethyl ether (1:2, v/v).

Radioactivity derived from rubratoxin B was present at maximum levels in the liver and kidney 8 and 15 hr, respectively, after administration. Insignificant amounts ( $<1.0\%$ ) were present in the other organs examined. The concentration of radioactivity was two times greater in liver than in other tissues at the end of 24 hr. The loss of radioactivity as respiratory  $CO_2$  decreased with time. Approximately 25% of the administered radioactivity was found in the respiratory  $CO_2$  by 2 hr.

Effect of Storage on Active Sodium Transport by Human Erythrocytes

Roger W. Voight and R. E. Taylor, Jr.  
Department of Physiology and Biophysics  
University of Alabama, Birmingham

It is well known that blood stored in a standard acid-citrate-dextrose (ACD) medium deteriorates rapidly until it is no longer suitable for transfusion after three weeks. We are investigating the possibility that this deterioration is due in part to a progressive decrease in the sodium and potassium gradients across the erythrocyte membrane due to a decline in active transport capacity, increased permeability, or both. Active transport was calculated from the difference in rates of efflux of  $^{22}\text{Na}$  from red cells into a glucose-supplemented bicarbonate Ringer's solution in the presence and the absence of ouabain. We found that the addition of adenosine during the measurement of active transport had little effect in fresh cells, but dramatically increased the rate of active extrusion of sodium in three-week old cells. Since one of the principal effects of adenosine is to markedly increase the ATP content of the erythrocyte (Simon, Transfusion 7:395, 1967) it would appear that the lower ATP level in stored blood causes a marked reduction in active transport capacity and lessened viability in these erythrocytes.

Responses of the Coronary Blood Flow of the Horse to Catecholamines

J. E. Webster, W.C. Bowie and D.A. McDonald  
Department of Physiology and Biophysics, University of Alabama  
and

School of Veterinary Medicine, Tuskegee Institute, Tuskegee, Alabama

With the application of flow probes directly on the left main coronary artery and one of its branches, anterior descending, myocardial blood flow was measured in the aorta at the coronary ostium, in the anterior descending artery, and in one of its distal branches. The pattern of blood flow in the horse is similar to that of the dog. During isometric contraction an abrupt decrease to 23% occurs in left main coronary flow. During ejection it increased rapidly to an intermediate level of 80%, which was followed by a transient period of retrograde flow in late systole. On early isometric relaxation, coronary blood flow increased to a peak of 1280 ml/min and progressively decreased for the remainder of the cycle. Intracoronary infusion of norepinephrine produced a biphasic response; initially coronary flow decreased 30% below mean control value of 1230 ml/min as pressures increased an average of 4% above the mean control values. In the second phase of the response, left main coronary flow increased 50% above the control value and pressures decreased an average of 11% below mean control value. Isoproterenol produced an increase in left main coronary flow of 18% while pressures decreased an average of 11%.

Ion Effects on the Zonal Fractionation of Rat Liver  
Subcellular Particles. I. Mitochondria

Phillip C. Weinberger and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Mitochondria from 1 g of perfused rat liver were banded isopycnicly in a B-XIV rotor using a discontinuous sucrose gradient of known ionic concentration. The mitochondrial band was found by using a modification of Cooperstein and Lazarow method for cytochrome oxidase. The density of the mitochondrial band was determined and compared with that of mitochondria in an ion-and-buffer-free gradient. Several such experiments were made with various concentrations of ions and it was found that magnesium ions at some concentration above 0.025 M cause the mitochondria to band at a slightly higher density. It was also found that if this change in banding density were elicited then addition of potassium equal to that of magnesium had no appreciable effect on the mitochondria but did affect the banding density of other cell particles.

It is thought that these observed effects of ions on mitochondrial banding density can be used in the improved separation of these particles from other cellular components which have a similar isopycnic density.

Isolation of Rat Brain Lysosomes in the B-XIV Zonal Centrifuge Rotor

Janice Williamson, W. Donald Fattig, and George B. Cline  
Department of Biology  
University of Alabama, Birmingham

Zones of lysosomal activity have been isolated by sucrose density gradient centrifugation in the B-XIV zonal rotor. The rotor was loaded with a seven step gradient (9%, 25%, 35%, 43%, 47%, 50%, and 60% sucrose). The brain homogenate was introduced into the 50% gradient step to allow for separation by flotation. Lysosomal activity was determined by the presence of acid phosphatase and B-glucosidase. Three lysosomal fractions were obtained at densities of 1.156-1.161, 1.197, and 1.219. The appearance of multiple peaks indicated a separation of different classes of lysosomes. However, since some of the activity zones corresponded to activity zones for other cell organelles, this could represent non-specific binding. The appearance of multiple activity peaks could also indicate that the lysosomes had been broken open and the enzymes dispersed throughout the gradient. Additional data are needed before a conclusion can be reached.

# The Pathways for Thiouracil Incorporation into RNA

M. Y. Wong and R. H. Lindsay

Departments of Pharmacology and Medicine  
University of Alabama in Birmingham, and Nuclear Medicine Service  
V.A. Hospital

Strominger and Friedkin (J. Biol. Chem. 208:663, 1954) demonstrated that 2-thiouracil (TU) can be converted to 2-thiouridine (TURE) by horse liver thymidine phosphorylase. This enzyme is widely distributed in mammalian tissues and provides a means for TU to enter the pyrimidine pathways. TURE was readily utilized as a substrate and formed 2-thiouridine-5'-phosphate (THIO-UMP). Thio-UMP was also formed by a direct conversion from TU by UMP pyrophosphorylase, a bacterial enzyme not normally present in mammalian tissues. Thio-UMP was converted into thio-UTP and a compound analogous to thio-UDP by a mixture of rat liver nucleoside mono- and di-phosphokinases. TURE-2-<sup>14</sup>C was readily metabolized by rat liver slices and formed thio-UMP and compounds appearing to be thio-UDP, thio-UTP, thio-UDP-glucose, thio-UDP-N-acetylglucosamine and thio-UDP-glucuronic acid. The identification of these metabolites was verified using column chromatography, two-dimensional thin-layer chromatography and autoradiography. Radioactivity of TURE-2-<sup>14</sup>C was also recovered in thio-UMP fraction of rat liver RNA hydrolysate. The pathways for TU incorporation into RNA thus appear to be essentially the same as those for uracil.

## ENGINEERING

### Experimental Investigation of Container Effects in High Speed Impact

David W. Cormany and Donald C. Raney

Department of Mechanical Systems Engineering  
University of Alabama, University

A review of the universal crater theory of Baldwin and Charters is presented. Consideration of prior experimentally produced craters as applied to this hypothesis leads to a conclusion of the possible existence of a heretofore neglected impact parameter. The shape of a semi-rigid, energy reflecting barrier surrounding the impact region is possibly a primary source of error in attempts to correlate laboratory produced impact craters with natural celestial body impacts. A series of experimental impacts is conducted in which this parameter is isolated. It is found that for an impact in the central transition range to fluidic impacts, as defined by Charters, peripheral confinement is a dominating influence on crater shape for containers ranging up to approximately 60 times the diameter of the impacting body. Container depth is found to be a contributing, though not dominant parameter in this type of impact. Six container shapes are investigated, and the resulting characteristic craters in 10-37 $\mu$  particulate pumice are presented. Several additional areas of possible work are raised, and a hypothesis is stated on application of the developed results to celestial mass concentration identification.



Rectangular Diagram Representation of Constant Resistive Networks

M.R.A. Erdey  
Electrical Engineering Department  
Tuskegee Institute, Alabama

Cherry (Proc. I.E.E. Vol. 107 (B):26-30, 1960) used the rectangular diagram method in his paper of non-linear iterative networks and found a resemblance between non-linear D.C. and Zobel's phase correcting linear iterative A.C. networks. Mayne (Proc. I.E.E. Vol. 107 (B); 410-411, 1960) has clarified the conditions under which these analogies will exist using also rectangular diagrams. Due to very picturesque nature of the rectangular diagrams, these diagrams give a much deeper insight into the behavior of constant resistive networks. In this article with the aid of rectangular diagrams the long overdue analysis and the design of constant resistive networks are exposed.

Computer-aided Design Procedure for 90-Degree  
Phase Difference Networks

Sidney S. Gussow  
Sperry Rand Corporation  
Huntsville, Alabama

A comprehensive computer-aided procedure is presented for the design of 90 degree phase difference networks commonly used in FM telemetry. The procedure includes determination of the required voltage transfer function, the phase response, and realization of the physical networks. Active all-pass networks are used to realize the phase shift functions which approximate a 90 degree phase difference over a specified frequency range.

The basic concepts of phase difference networks and all-pass networks are given along with practical hints for the construction of the active all-pass networks. The design and construction of a 10th order, 10 Hz to 3000 Hz phase difference system, used in a frequency division demultiplexer, is presented as a design example.

A Digital Data Acquisition System for Watershed Research

R.E. Hermanson, A.M. Flikke, and J.G. Hendrick  
Departments of Agricultural Engineering  
Auburn University and University of Minnesota,  
and National Tillage Machinery Laboratory,  
Auburn, Alabama

A series of runoff plots and a weather station have been constructed at the Agricultural Engineering Research Unit near Marvyn, Alabama. Because of the large volume of data to be collected and analyzed, it was considered necessary to use an automatic recording system that produced a computer-compatible record. An off-line data acquisition system was developed, rather than an on-line or time

sharing approach. The system selected was a standard unit, with certain special modifications, obtained from Analog Digital Data Systems, Inc. The system records on magnetic tape data from a clock, a digital accumulator, and 100 analog channels. The system must make the analog-to-digital conversion of the data because the university computer center does not have the capability to digitalize analog data. Data are recorded at two pre-selected time intervals. Some data are recorded at two-minute intervals and some every 30 minutes.

The system was designed to record the following data from eight small watershed plots and a weather station: 1) rainfall, 2) runoff from eight 0.1-acre plots, 3) air temperature, 4) water temperature in an evaporation pan, 5) land pan evaporation, 6) dewpoint, 7) wind velocity and direction at the evaporation pan and at a 12-foot elevation, and 8) total and net solar radiation.

### A Probability Density Analyzer

William A. Hopper  
Sperry Rand Corporation  
Huntsville, Alabama

The design, construction, and operation of a device which plots the amplitude probability density function of the input voltage are presented. Such a function is useful in describing the statistics of a signal, which is of utmost importance for noise considerations. An important goal of the analyzer is accuracy, and therefore some digital techniques are utilized. An analog device, called a "slicer", is used in conjunction with digital clocks, counters, shift registers, and a D/A converter in driving the Y channel of an X-Y recorder. The plot thus obtained is proportional to the fraction of time the signal spends at a particular level, and in the limit, the output is the probability density function of the input voltage. Some examples are presented and some practical applications are noted.

### Creep Flow with Non-Vanishing Velocity Normal to a Plane Boundary

C. K. Liu  
University of Alabama, University

Corresponding to two modes of normal velocity variation along a Cartesian plane boundary, an exact solution of creep (Stokes) flow in terms of the fluid pressure and the fluid velocities is presented. Typical continuous and discontinuous velocity variations are chosen for the boundary conditions to simulate the different manners of steady state evacuation of crude oil from oil fields for various states of pumping activities.

The present nondimensionalized solution shows that for a certain boundary velocity variation there are positive and negative pressure peaks occurring in the fluid. Although these pressure peaks diminish

rapidly from their extreme values at the boundary with increasing depth, their magnitudes can become infinitely large wherever a "mathematical" discontinuity exists in the boundary velocity variation, i.e., in the pumping activities. The fact that the fluid pressure can actually change for a maximum to a minimum over a relatively small region of the boundary indicates the presence of large shearing stress in the boundary at or near the border of the site of evacuation. It is not hard to believe that the integrity of the boundary or the oil bearing earth crust should become a great concern to the oil explorer and the residents of the region of pumping activities.

#### Receiver Antennas for Application in a Television Broadcast Relay System

J.M. Loomis, III and E.R. Graf  
Department of Electrical Engineering  
Auburn University, Auburn, Alabama

Various types of antennas are considered for use as UHF home receiving antennas involving a synchronous satellite relay link. A brief survey of present UHF antennas and their application in this system is presented. Spiral and helical antennas are considered and designed for this mode of operation.

#### An Evaluation of the Toughness of Metallic Materials Based Upon Energy Dissipation

Edward J. Planz, Edmund J. Wheelahan, and Bruce R. Nelson  
Department of Chemical and Metallurgical Engineering  
University of Alabama, and  
U.S. Army Missile Command, Redstone Arsenal, Alabama

To evaluate the toughness of materials either ferrous or non-ferrous one may employ the impact test. For this test the material is machined into Charpy, Izod, or V-notched Charpy specimens which are then subjected to a striking hammer, whereupon the energy absorbed is recorded in footpounds. However, an impact machine instrumented with strain gages and an oscilloscope has been utilized to record this same energy. In our investigation an advancement in the state of the art was made with regard to experimental instrumentation in addition to further and different utilization of the data. Even the oscillations usually prevalent in the oscilloscope trace of other investigators were absent in this investigation, thus making the trace well delineated. As a result, a correlation was made possible between actual mechanical test results and specific portions of the oscilloscope trace. Static tensile properties such as ultimate and yield load, and per cent elongation could be determined within experimental error from the oscilloscope trace.

## Abstracts

### A Thermal Scale Model with Experimental and Theoretical Results

James W. Price  
Marshall Space Flight Center  
Alabama

A model was investigated that maintained both material and temperature preservation at homologous locations. The prototype and model, which were built and tested, were cylindrical fins. Also, mathematical models of the prototype and model were solved using the computer. It is shown in this report that this approach gives accurate results when the model is simple. The experimental and theoretical results are presented in tables and graphs.

### Organization Theory: An Engineering Tool

Wyllys G. Stanton  
Department of Industrial Engineering  
University of Alabama, University

Organizations are groups of people working with purpose to accomplish individual goals and thereby achieve a common goal. Designing the relationships and controlling the activities of the persons involved constitute a body of knowledge, theory, and practice which has been studied primarily by the behavioral sciences. This theory is also a very useful tool in engineering work and all engineers should devote time and effort to its study. Rapid growth of technology makes it difficult for working engineers to find time for organization theory, but it is possible to study the elements or to hire an industrial engineer who can also be useful in many other ways.

Although the theory is vast, even a paper such as this can give some of the elements and adequate references. Some of the salient points are: structure, the relationships of the parts of organizations; types of organizations, line and staff positions; the delegation of authority and assigning of responsibility.

Principles of organization, applicable whether the problem is operating a bank, a railroad, or other enterprise, are: span of control or number of persons assigned to a supervisor; functional or task organization versus product organization; assignment of all functions and a study of objectives.

### A Fortran Algorithm for Expansion of Computer Memory

Carlton M. Turner  
Sperry Rand Corporation  
Huntsville, Alabama

An algorithm is presented which produces an approximate 50% increase in alphanumeric character storage in digital computers. The technique makes use of a positional number system with a base of 40.

The algorithm is also useful for packing quantized numeric values in a highly efficient manner. The algorithm makes use of the equation

$$K_n = (C_{(n-1)} \cdot K_{n-1})_{\max} + K_{n-1}$$

in determining multipliers for the positional notation.

#### An Odor Removal Study

B.G. McKinney, B.B. Barisa, F.T. Wells, and J.R. Sulcer  
Marshall Space Flight Center and Brown Engineering Company  
Huntsville, Alabama

A cursory analysis of an odor control unit which is capable of removing hydrogen sulfide is presented. The results of an experimental program for two materials which remove H<sub>2</sub>S are presented and compared to the predicted values. The results indicate that charcoal is an efficient material for removal of H<sub>2</sub>S whereas Sanalin<sup>R</sup> is not nearly as efficient at the flow rates considered in the experimental program.

#### Automated Return of Mars Surface Samples to Earth

Pat R. Odom  
Northrop Corporation  
Huntsville, Alabama

This paper reports on recent studies to investigate the feasibility of the most complex and probably the most technically challenging automated planetary space mission yet conceived. The primary objective is to return physical samples of the Mars surface to the Earth. The potential scientific return is great. The paper discussed the entire mission system concept based on using the Apollo Saturn V launch vehicle with either the existing chemical third stage or a new nuclear third stage.

#### The Effect of Certain Combine Parameters on Harvesting Damage to Peanuts

Kenneth M. Penuel and William F. Lalor  
Department of Agricultural Engineering  
Auburn University, Auburn, Alabama

The evolution of the present high capacity cylinder-type combine has brought with it the disadvantage of potentially high hull damage if not operated properly. Objectives of this study were to determine the factors contributing to this damage and to suggest possible solutions to the problems at both the combine-manufacturer and combine-operator levels. Factors studied were combine cylinder speed, stripper-bar orientation, and cylinder tooth density. The cylinder section of a PTO-driven Lilliston combine was used in the test. Five replications of an 18-treatment test were run to determine the main effects and interactions of the combine parameters under observation.

As the combine cylinder speed increased, damage to the hull also increased. The aggressiveness of the picking action and the hull damage increased as the stripper-bars were extended into the picking section of the combine. The tooth density had no significant effect on the amount of hull damage. The ability of the combine operator to compensate for changing picking conditions of the peanuts with adjustments to the combine is an important factor in determining the amount of damage done to peanuts during harvest.

## Abstracts

### Telemetry System Testing with Pseudo Random Signals

G.D. Weathers  
Auburn University  
Auburn, Alabama

The necessity of developing a method to evaluate a telemetry system's performance in handling complex signals, rich in spectral content, is established. Measurement of the RMS value of the difference between channel input and output is shown to yield a meaningful figure-of-merit for system performance. A description of an arrangement to achieve the measurement is given, and the need for a broadband test signal is established. The problems that prohibit the utilization of true noise as a test signal are discussed, and the use of a pseudo random signal generated by digital techniques is investigated. The conclusion is that these pseudo random waveforms do indeed offer many advantages as test signals. An outline of the design of an instrument to perform the RMS error measurement is presented.

### Wave Propagation in an Anisotropic Material with Both Tensor Permittivity and Tensor Permeability

Oliver Charles Williams, Jr.  
Auburn University  
Auburn, Alabama

Wave propagation in an anisotropic material with both tensor permittivity and tensor permeability is investigated through the development of a dispersion equation for the medium. The more general dispersion equation is seen to reduce to Appleton's equation for "cold plasmas" under the assumption of tensor permittivity and scalar permeability. The ferrite case is obtained assuming a tensor permeability and a scalar permittivity. For both scalar permittivity and scalar permeability, the equation reduces to that for the isotropic case. Solutions for the general equation as well as that for the "cold plasma" and the ferrite are obtained. Brillouin diagrams are drawn yielding phase and group velocity information. Comparisons are made between the different mediums and similarities are illustrated.

## ANTHROPOLOGY

### The Ute Indian Today

Charles H. Ainsworth  
University of Montevallo  
Montevallo, Alabama

The "average" Ute Indian today has completed about nine years of formal schooling and has some vocational training. His family's income is about \$2,600. If he is male, he is employed in a menial job; if female, she is unemployed. The Ute believes that Indian money should be kept on the reservation by encouraging the establishment of industry on the reservation which would hire Indian employees.



He lives in a house located in a small rural community having an Indian population of less than 250 persons. His house is overcrowded; however, it is equipped with electric lights, television, radio, refrigerator, washing machine, and gas or electric stove in the kitchen. The typical Ute receives his information of the world most often through radio and television rather than from books or other reading literature.

The more serious health problems are respiratory disease, arthritis, or rheumatism.

He is a member of a formal church, most likely the Episcopal Church; however, his attendance is infrequent.

The limitations to change among the Utes to become more like the dominant U.S. whites seem to be due to: (1) the relative isolation of the reservation, (2) a continual dependence on the government for certain subsistence items, (3) conceived and real differences between the Utes as Indians and the dominant American whites, and (4) an inability and/or lack of desire to "catch up" in the areas of education and occupational training in a society undergoing constant change and increased specialization.

Should Marijuana Be Legalized: An Opinion Survey of  
Montevallo University Students

Charles H. Ainsworth  
University of Montevallo  
Montevallo, Alabama

The results of this study do not support the view that more education is positively correlated with favoritism toward the use of marijuana.

This particular study indicated that those mostly favoring the legalization of marijuana were males, Catholics, social science and humanity majors, and politically liberal persons, especially those who preferred Eugene McCarthy as a presidential candidate. Those who were most in disagreement with the legalization of marijuana were females, Protestants, education and business administration majors, and politically conservative persons, especially those who preferred George Wallace as a presidential candidate.

Of the total responses to the survey, only 28% voted in favor of the use of marijuana--and this only on the condition that its use be controlled. The percentage voting in favor of complete legalization of its use without restrictions was 2.6.

Some Problems in Researching Southeastern Ethnobotany

Marguerita L. Cameron  
University of Alabama, University

Ethnobotany, a new discipline to Alabama, will eventually become one of our most valuable tools for interpreting and dating archeological finds through the study of archeological plants remains. However, there is a large problem inherent in the hot, moist climate of Alabama--plants tend to deteriorate quickly so that plant debris will usually be limited to seeds, charcoal, and pollen. The other problems center around the specialized knowledge needed to work with these materials and the necessity of consistently applying proper techniques of collection and storage. The literature on aboriginal plant usage in Alabama will be of little use. It is vague, often inaccurate, and too general to serve as much more than background information.

These problems and problems like them have been solved in other regions. The value of ethnobotanical data will make the effort worthwhile.

The Salt Creek Site, An Important Salt Gathering  
Station in Southwest Alabama

David W. Chase  
Montgomery Museum of Fine Arts  
Montgomery, Alabama

In various parts of the state of Alabama, a specialized ceramic ware associated with salt processing has been found from time to time. This pottery, known as Langston Fabric Impressed, is best known as "salt pan ware" since it has been found in conjunction with salt processing in other parts of the southeast. On the Stimpson (sp) Wildlife refuge about 12 miles south of Jackson in Clarke County, a large site was found at the mouth of Salt Creek which flows through the refuge area. According to local historical sources, salt was processed at this place during the Civil War and brine pits, presumably dating to that time, may still be seen on the site.

A visit to the site area on January 1 of this year resulted in the recovery of a great amount of Indian pottery to include many sherds of "salt panware". This shell tempered pottery was made in the form of a shallow dish slightly depressed in the center. The outer surface was deeply impressed with a mesh fabric or woven rush matting. Shell tempered pottery, associated with this ware, is probably Mississippian in age. Sherds of earlier Woodland Culture levels were also found in quantity, implying a long term use of the site as a salt gathering and processing station.

Although no laboratory tests were made, water samples of the nearby Salt Creek were tasted and found to be highly saline. Objects moistened with water from this creek and allowed to dry showed a whitish residue which appeared to be and tasted like salt. It was

assumed that salt had dissolved into underground water from natural deposits through which it passed. The mineral was commercially recovered by the process of evaporation.

This site is significant since it may be the State's only documented salt gathering station of prehistoric vintage and would yield a vast amount of data relating to prehistoric salt recovery and its role in trade and economics of pre-Columbian Alabama.

The Relationship of Energy Depletion and Architectural Features  
in the Hay Hollow Valley, Northeastern Arizona

Boyce N. Driskell  
University of Alabama, University

During the summer of 1969, the Southwestern Archaeological Expedition, sponsored by the Field Museum of Natural History and the National Science Foundation, carried out research in the Hay Hollow Valley east of Snowflake, Arizona. The relationship of energy depletion and architectural features was but one of several endeavors. This paper proposes to test two hypotheses that attempt to explain the relationship of architectural features and energy levels in a sample of pueblo sites in the valley. The evidence gathered indicates a positive correlation for factors tested.

The Castizo and the Jade God: An Interrupted Heritage

Sarah A. Glass  
Samford University  
Birmingham, Alabama

In some parts of rural Mexico, the offspring of a Spanish woman and an Indian man are referred to as "castizos." Such a union is frowned upon, as evidenced by the fact that in these areas mules are called castizos.

Nick, now a successful licensed guide working in Mexico City, was born a castizo in the Tarascan segment of the peasant village of Tzintzuntzan, Michoacan. His parents were married in a civil ceremony in Morelia, but neither his mother's family nor the Catholic Church recognized the marriage, the latter refusing to allow them to be married in the church. The priest later refused to allow the children born to this marriage the privilege of attending the village school, saying that castizos were too stupid to learn.

The Spanish mother continued as a communicant in the Catholic Church, and the Tarascan father remained faithful to his pagan gods, the most important of which was the God of Fertility. The father, acquiescing to the mother's pleas to accompany her to mass, would sit through the service with his hand inside his shirt, clutching the three-headed Jade Fertility God that hung from jade beads around his neck.

## Abstracts

The father died when Nick, the oldest of the five children, was sixteen years old, and the mother had the Jade God buried with the father. The idol had been handed down from father to first-born son for generations, and having it buried with his father, rather than pass to him, symbolized for Nick the end of his father's line. The "death" of the idol at the time of his father's burial thus represented a double tragedy for him. He had lost not only his father, whom he loved and admired, but had lost his identity and heritage as well.

After the father's death, his family moved to Mexico City where Nick went to night school, starting in the second grade. He later married a girl from France, whom he met while she was on tour in Mexico; he now has three children of his own.

Now successful in his life in the city, the events of his early years nevertheless weigh heavily on him. He feels that his father's worth must be vindicated, and his Indian inheritance reclaimed. He plans to exhume his mother's body in Mexico City, and take it to Tzintzuntzan for reburial at the side of his father. When this happens, he intends to take the Jade God from his father's grave, thus symbolically giving new life to his father's line. His own son is a product of urban socialization and does not identify with the Indian part of his ancestry. Nick therefore fears that at his own death the Jade God would again become lost. To avoid this, he plans to give the idol to the Museum of Anthropology in Mexico City, to take its place among other symbols of the proud past of his father's forebears. In this way, symbolically, his father's line will live forever.

### Glimpses of Yucatan's Henequen: Botanical, Technological, and Cultural Angles

Regina J. Kinsaul and Asael T. Hansen  
University of Alabama, University

In the Amaryllidaceae family of plants the largest genus is *Agave*, widely grown for juice and/or fiber. Two species, *A. henequen* and *A. sisal*, are native to Yucatan and have served as sources of fiber since pre-Columbian times. Yucatecans refer to both as henequen.

Large-scale commercial production of henequen began about 1870. Developments in the international market led to a glorious boom between then and 1920. A one-crop economy emerged. As soon as problems of acclimatization of the plant could be solved, cultivation spread to other countries. East Africa and Indonesia became serious competitors along with India, the Philippines, and the West Indies. Today, all producers of natural fiber face an awful threat, i.e., that synthetics may under-price them in the near future.

The nature of the plant makes Yucatan's escape from its henequen-based monoculture difficult. Henequen grows well on thin rocky soil; not many crops do. So, the considerable rural population in the henequen zone has no ready alternatives. Moreover, it takes the plant

seven years to produce leaves containing marketable fiber. It continues producing, with proper care, for about a dozen years. Then, a flowering stalk develops and the plant dies. The initial investment is great and subsequent expenditures are substantial.

In recent years the Mexican Federal Government has been trying to cope with what is a political as well as an economic problem--involving, as it does, the subsistence of thousands of voters. There are price controls, wage controls, subsidies, and searches for new uses for the fiber. In the capital city of Merida, a Government factory is adding nicely-dyed rugs and cloth to the traditional twine, rope, and bags. An odd consequence is that the factory has to import foreign fiber into the very home of henequen. It appears the Government does better with new-fangled fabrication than with the old fashioned growing of henequen in the fields.

The main staples of Yucatan, long before henequen emerged as the predominant source of wealth, were maize and beans. The slash-and-burn system, which provided people with these basic foods, was deeply involved with the supernatural. In trouble, prayerful requests for aid went to the gods of forest and fields and rain.

Large-scale henequen has always been a secular crop. In the current crisis, people turn to the Government, and the Government turns to technology and science. The gods are ignored in the new days with their new ways.

#### Proportions and Disproportions Using Somatometry

Susan V. Merkel and Evelyn Brannon  
Department of Consumer Affairs  
Auburn University, Auburn, Alabama

This study using "Graphic Somatometry" is entitled "Relationships of Postural Variances." The purposes of this study were 1) to observe the frequencies of selected variance, and 2) to determine the extent to which the variances were related to each other. The sample consisted of 133 college girls. Each subject had a set of photographs made in the laboratory which consisted of a "somato-graph" and a "posture-graph." The photographs were then analyzed and variances from the norms quantitatively expressed according to the *Douty Posture* chart and the *Douty Body Build* scale.

This study showed that variances were frequent in the population and most people revealed more than one. Variances were related to each other as most people with a postural variance tended to compensate by moving some part of their body to maintain balance and thus cause another variance to occur. In order to improve or remedy variances a person must first realize he has this variance. Graphic Somatometry is a method for making an objective view of one's self possible.

## Abstracts

Another application of Visual Somatometry is in the study of proportions. Proportion in this study may be defined as the relative size of various body segments to each other and to the total height. The purpose of this study was threefold. First, to develop a further application of Dr. Dauty's system of Visual Somatometry. Second, to develop a methodology of the study of proportion. Thirdly, to begin an analysis of data to establish guidelines and eventually lead to norms for proportions. The sample was 133 college-age females. Body segments were defined and counted. Findings were reported in the percentage of body segments to total height. The conclusions were:

- 1) Proportions may be defined and studied logically by use of Visual Somatometry.
- 2) Proportional data collected and analyzed in this way may lead to a realistic, systematic proportional system.
- 3) Proportions are relatively similar through the population and regardless of height.

### Preliminary Investigations at Pinson Cave (1Je-20)

Carey B. Oakley Jr.  
University of Alabama  
University

Pinson Cave was brought to the attention of Dr. Paul Nesbitt, Head of the Department of Anthropology, by the Jefferson County Sheriff's Department in October, 1969. The Sheriff's Department was concerned about certain human bones that were discovered in a small limestone cave near Pinson, Alabama. Thinking that these remains may have had some bearing on a previously unsolved criminal case, they requested aid from the Department of Anthropology to investigate and determine the circumstances of the find. The preliminary results of this investigation indicated that this was not a recent burial but instead was part of a very unusual prehistoric site. To date, this site does not conform to any on the previous excavated archaeological sites within the south-east. The fact that a tremendous amount of both animal and human skeletal material was deposited in complete disarray and associated with only a small amount of cultural artifacts indicates that the place was not a habitation site, but instead possibly served a ceremonial purpose. It is felt that further excavation of the cave should yield valuable information as to the events, the time sequence, and the cultural developments which are reflected at this site.



## MULTIPARAMETER OPTIMIZATION APPLIED TO SPECTRAL DATA

Thomas R. Edwards  
NASA/MSFC  
Marshall Space Flight Center, Alabama

## INTRODUCTION

In the operation of spectral equipment, the output consists basically of spectral position and spectral intensity. This paper will discuss the application of a multiparameter optimization technique which has been applied to theoretical mass spectral data, and the approach to be taken in applying the technique to experimental data.

The justification for applying this technique lies in the improved quality of a spectrometer's output information. With this improved information there appears to be an increased likelihood of doing gaseous chemical analysis in air pollution, health physics, and in the Apollo telescope mount contamination studies to lower parts per million concentration.

Spectral shape resulting from the low-resolution detector in a CEC Residual Gas Analyzer appears to be somewhat Gaussian (Fig. 1). The curve is a bit too flat on top to be purely Gaussian and can be fitted empirically with a transcendental expression of the form:

$$Y_i = Y * e^{-\beta(R) \frac{X_i - X}{X}^{AN}}$$

where  $X_i$  = spectral position;  $Y_i$  = spectral intensity;  $X$  = spectral position at peak;  $Y$  = spectral intensity at peak;  $\beta(R) = 0.693 \times R^{AN}$  where  $R$  = resolution (half width at half max); and  $AN$  = shape-dependent function.

The desirability of fitting the data to such an expression is threefold: (1) The expression permits optimization of the spectral position and intensity; (2) It allows optimization of  $AN$  and  $R$  from calibration data, a sample for which the spectral positions are accurately known; and (3) It possesses the ability to unfold overlapping spectra.

Since an exact solution to this transcendental expression is not available, the problem was formulated into an attempt to optimize these spectral parameters by a pattern-search technique.

## APPROACH TO SOLUTION OF PROBLEM

The Hooke and Jeeves algorithm is a pattern-search approach towards optimizing an  $N$ -dimensional vector by satisfying a criterion function. As such, the algorithm is ideally suited to optimizing the parameters associated with spectral data.

## DISCUSSION

The algorithm can be described as a five-part logic (Fig. 2). First, an effective criterion function must be established. A criterion function is, by definition, any mathematical representation which is related to all the parameters in such a fashion that a bad set of parameters will increase the criterion function while a good set of parameters will decrease this function, or vice versa. The condition of least squares is the criterion function in a multiparameter regression problem. Whereas regression calculations are algebraic and allow the optimum parameters to be obtained from a solution of a set of normal equations, no such calculus is available for transcendental expressions. However, as a criterion function, the least squares condition is applicable to a transcendental expression if one assumes a normal distribution of data. Therefore the criterion function in this multiparameter search algorithm will be established as a minimization of the RMS deviation resulting from the transcendental expression and the experimental data.

In any search problem, a starting point must be established. The better the starting point, the quicker a solution is reached. Therefore, as much logic as possible should go into establishing good initial values for the parameters. Good beginnings require algorithms which are usually unique to each problem and can be the determining factor in the time required for the pattern search to be effective.

The third part of the logic is concerned with the step size associated with each parameter. The step size determines the length of the move that the parameter is allowed to make in advancing toward its optimum value. The initial value of the step size for each parameter can be determined in the following manner. If the initial parameter is known accurately to two significant digits, variations considered will be from the third digit on, then step size of 0.9% of the initial value would be appropriate. (This allows approximately 100% deviation in the third digit.)

The last two parts of this five-part logic are concerned with the search moves.

Two types of move are actually involved in the pattern search. After the starting point or base point for this iteration has been established, exploratory steps are taken along each axis in the N-dimensional space, according to the step size defined for each parameter. This exploration has three possibilities: it may add or subtract the step size from the value of the parameter or may leave the parameter unchanged.

The decision to change the parameter in either direction or retain its original value depends on which choice lowers the RMS deviation (the value of the criterion function). If the parameter remains unchanged, the step size associated with that parameter is halved and the exploration proceeds along another axis. This reduction in step size represents an increase in sensitivity towards lowering the criterion function.

Exploring each axis in this manner and combining the results advances the search from the base point to the midpoint for this iteration and allows a vector direction or a pattern to be established. The vector direction is then determined by the net displacement between the base point and the midpoint. Based on the assumption that whatever constituted a successful exploratory move is likely to do so again, an advance in the established vector direction is made. The net displacement between the current base point and midpoint is added again to the midpoint to obtain the final point for the iteration. This final point is then advanced as far as possible by the net displacement (adding the net displacement to the final point), always examining the criterion function to assure that the move was good.

The major advance towards the optimum values of the parameters for this problem takes place in the pattern moves. When a pattern move goes beyond a good point, indicated by an increase in the RMS deviation, the multiparameter Vector retreats to the last good point which now acts as the base point for a new set of exploratory moves, with the reduced step size.

Thus, from the initial base point to the final optimum values of the parameters, the whole process iterates to produce a lower and lower step size and subsequently a minimum in the criterion function. The iteration process can be stopped by any number of conditions. This algorithm uses a predetermined value of the criterion function as a cutoff point as well as a predetermined limit of the step size.

#### APPLICATION TO EXPERIMENTAL DATA

The Hooke and Jeeves algorithm is applied to spectral data in the following manner. A calibration sample, one whose spectral positions (atomic mass units) are accurately known, is input to the residual gas analyzer. The data are recorded on a magnetic tape system and input to the computer. The initiation algorithm establishes the initial values for the spectral position and intensity, AN and R for each peak separately and the problem is formulated into one designed to optimize these four parameters only. The optimum values for AN and R for each peak are averaged and their statistical deviations calculated. If the statistical deviations are within allowed limits the average AN and R are stored for future use. Otherwise, the calibration run is rejected and equipment diagnostics are output. The optimum voltage values for spectral position are fed into a linear regression problem correlating mass number values in atomic mass units to voltage units. The slope, intercept and RMS deviation are calculated. If these three parameters are within allowed limits they are stored for future use. Otherwise, as above, the calibration run is rejected.

Once having accurate values of AN and R, these two parameters can be used on unknown spectra for an optimization of Y and X, the spectral intensity and position.

# Multiparameter Optimization

## THEORETICAL OVERLAP PROBLEM

In many instances spectral peaks overlap and in cycloid design mass spectrometers this overlap increases as the spectral range is extended. Since overlap can lead to spurious peaks, a theoretical problem of three apparent peaks, resulting from the overlap of two real peaks, was approached. Could the Hooke and Jeeves algorithm distinguish the two real peaks from the three apparent peaks?

As in an experimental case, the R and AN were known from a calibration sample. The three spectral peaks and intensities were calculated by the initialization algorithm. The initiation algorithm uses the first, second, and third derivatives for determining inflection points and peak point. A variable dimension multiparameter vector and associated criterion function were established (Fig. 3). Dimensionality was set equal to two times the number of peaks; a peak represents two parameters, position and intensity. From the initial guesses, there appeared no way to distinguish the two real from the three apparent peaks (Fig. 4). The six parameters were input to the Hooke and Jeeves search which was modified by the following constraints:

- (1) If an intensity value falls below a specified value in the process of the search, the peak with this intensity is eliminated from the set of parameters and the dimensionality of the problem is reduced by two.
- (2) If the relative difference between two values of the spectral positions falls below a certain percentage, the two peaks are combined into one, averaging the current values of the position and taking the sum of the two intensities as the new parameter. The step size for the two new parameters is then reinitiated, and the exploratory moves are begun again to optimize the resulting parameters.

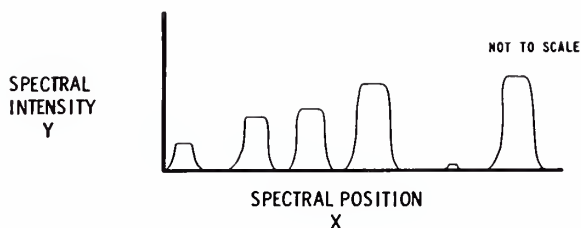
With these constraints, the search program was able to accurately distinguish the two real peaks from the three apparent peaks and the optimum values determined for the parameters agreed favorably with the theoretical values (Fig. 4). Only two iterations were required to obtain these optimum values.

## CONCLUSIONS

Although this problem represents only theoretical data, the technique has been very successful in abstracting the real spectral peaks from apparent peaks. Thus the technique appears quite capable of being successful on experimental data, and optimizing the parameters associated with spectral peaks. With the data being abstracted on a magnetic tape system for computer processing, this optimization technique should be capable of abstracting more information from spectral data than present techniques allow.

## ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Dr. Ralph Huntsinger of the South Dakota School of Mines and Technology for an introduction to the Hooke and Jeeves logic, and to Mrs. Linda Slone of Auburn University for assistance in developing the computer programs.



$$Y_i = \bar{Y} \cdot e^{\left[ -\beta(R) \left[ \frac{X_i - \bar{X}}{\bar{X}} \right]^{AN} \right]}$$

WHERE

- $Y_i$  = SPECTRAL INTENSITY
- $X_i$  = SPECTRAL POSITION
- $\bar{Y}$  = SPECTRAL INTENSITY AT PEAK
- $\bar{X}$  = SPECTRAL POSITION AT PEAK
- $(R) = .693 \cdot R^{AN}$  WHERE R = INSTRUMENT RESOLUTION  
(HALF WIDTH AT HALF MAX)
- AN = SHAPE DEPENDENT FUNCTION

FIGURE 1. Spectral data Hooke and Jeeves algorithm

1. ESTABLISHMENT OF AN EFFECTIVE CRITERION FUNCTION.
2. ESTABLISHMENT OF A STARTING POINT.
3. INITIALIZATION OF STEP SIZE.
4. EXPLORATION ALONG EACH AXIS IN THE N-DIMENSIONAL SPACE.
5. ESTABLISHMENT OF A PATTERN OF MOVEMENT.

#### LOGICAL FLOW CHART

##### INITIALIZATION

CRITERION FUNCTION  
BASE POINT  
STEP SIZE

##### EXPLORATORY MOVES

ADVANCE  
RETREAT  
STATIONARY

##### PATTERN MOVES

VECTOR DISPLACEMENT  
FINAL POINT

FIGURE 2. Hooke and Jeeves algorithm five part logic

$$Y(I) = \sum_{J=1}^M X(J+1)e \left[ -\beta(R) \left[ \frac{XX(I) - X(J)}{X(J)} \right]^{AN} \right] \quad J = 1, 3, 5, \dots, M$$

$$RMS = \sqrt{\sum_{I=1}^N [YY(I) - Y(I)]^2 / N}$$

X = MULTIPARAMETER VECTOR  
 X(EVEN) = INTENSITY VALUES  
 X(ODD) = POSITION VALUES  
 XX = POSITION VECTOR  
 YY = INTENSITY VECTOR  
 N = NUMBER OF DATA POINTS  
 M = 1/2 DIMENSIONALITY MULTIPARAMETER VECTOR  
 RMS = CRITERION FUNCTION

FIGURE 3. Hooke and Jeeves algorithm criterion function

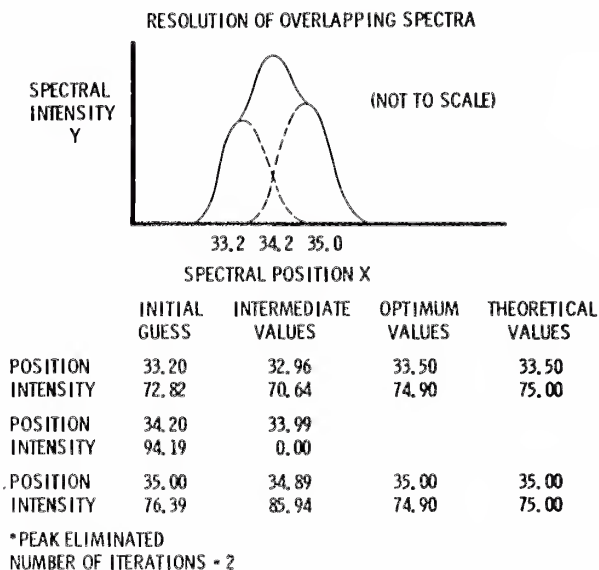


FIGURE 4. Spectral data Hooke and Jeeves algorithm



AUTOMATED TREATMENT OF CRITICALLY ILL PATIENTS FOLLOWING OPERATION

L.C. Sheppard, N.T. Kouchoukos, J.C. Acton, Jr., and J.W. Kirklin  
Department of Surgery  
University of Alabama Medical Center  
Birmingham, Alabama

At the University of Alabama Hospital we have been using instrumentation, an IBM 1800 computer system, and remote terminals for the observation and treatment of patients during the first 24 to 48 hr following open intra-cardiac operation for correction of various acquired and congenital heart defects (2).

Measurements are derived from the electrocardiogram, an indwelling arterial catheter, left and right atrial catheters, a rectal temperature sensor, chest drainage tubes, a urinary catheter, and a pulmonary artery catheter (3). The automatic aspects of the system include computer control of blood infusion, intravenous maintenance fluid administration, mannitol infusion, and drug infusion.

Extensive use is made of commercially available transducers, electronics, and electromechanical devices. Special attention is given to electrical safety and sterility. Temperatures are sensed with Yellow Springs thermistor probes. Vascular and intracardiac pressures are converted to their electrical analogs by means of Statham P23 series pressure transducers and Hewlett-Packard carrier preamplifiers.

Units were assembled in our laboratory to facilitate the measurement of chest tube drainage and urine output in the containers normally used for their collection. The chest drainage suction bottle is supported by a platform attached to a Statham UC3 load cell (1) and the plastic bag for urine collection is suspended from an identical load cell. These devices and their associated electronics are enclosed in a protective frame equipped with restraining clamps to anchor the plastic tubing so that each tube contributes a constant deflection which is subtracted from the measurements. Direct current is used to excite the load cell bridges and the D.C. amplifiers have been calibrated by a method which takes into account the specific gravities of chest drainage and urine so that the voltage outputs are equated with milliliters rather than grams.

A peristaltic type roller pump driven by a stepping motor is used for infusing blood under computer control. The stepping motor is excited by a translator which is pulsed by an oscillator at a frequency calibrated to deliver 20 ml of blood at a rate of 0.5 ml/sec. If left atrial pressure and arterial systolic pressure do not exceed their respective limits, an infusion cycle is initiated by the computer via electronic contact operate. A time delay relay terminates the cycle 40 sec later. If either pressure measurement exceeds its limit no blood is infused (3).

We have designed and constructed a system for computer controlled infusion of intravenous fluids and drugs including mannitol, Arfonad, Xylocaine, and Isuprel. A drip sensing assembly containing multiple

photocells and light sources is affixed outside the microdrip chamber (1). The signal conditioning circuit turns off the infusion pump when no drips occur and signals the computer that the unit of fluid is empty. During normal infusion the circuit provides the computer with pulses to permit measurement of drip rate using the computer's pulse counter input feature. The direct current motor connected to the roller pump is driven by a Kepco operational D.C. power supply which is programmed by the computer using a digital to analog converter. A Fortran subroutine utilizing a simple proportional control algorithm adjusts the analog output to compensate for deviations between the desired  $\mu\text{drops}/\text{min}$  (set point) and the measured  $\mu\text{drops}/\text{min}$ . Drip rates can be specified by entering the desired value at the bedside terminal or by computer programmed computation based on control rules associated with other variables such as mean arterial pressure, body surface area, heart rate, or cardiac output.

Clinical measurement of cardiac output is based upon an indicator dilution technic. A 5 mg bolus of indocyanine green dye is injected in the right atrium and the dye concentration in the pulmonary artery is detected by withdrawing the blood through a Waters XC250 Cuvette Densitometer with a Harvard Syringe Pump at 7.5 to 15 ml/min. The computer is used in calibrating the densitometer, acquiring the dilution curve, and calculating the cardiac output by the Stewart-Hamilton method. The result is converted to cardiac index and used with the left atrial and arterial systolic pressures to set limits for automatic blood infusion and ascertain the need for pacing, or the infusion of vasoactive or inotropic agents. (Supported in part by Alabama State Department of Vocational Rehabilitation and NIH Grant He 11310-01).

#### LITERATURE CITED

1. Chaapel, D.W., G. Rastelli, and R. Wallace. 1969. On-line computer care of post operative cardiac patients. Digest IEEE Computer Group Conference, 69C30-C:105.
2. Sheppard, L.C., N.T. Kouchoukos, J.W. Kirklin, and J.C. Acton. 1969. Surgical intensive care system. Proc. 8th ICMBE and 22nd ACEMB, 17-10.
3. Sheppard, L.C., N.T. Kouchoukos, M. A. Kurtts, and J. W. Kirklin. 1968. Automated treatment of critically ill patients following operation. Ann. Surgery 168:596.

MINUTES  
ANNUAL BUSINESS MEETING  
HALEY CENTER, AUBURN UNIVERSITY, AUBURN, ALABAMA  
April 11, 1970

The Annual Business Meeting of the Academy was called to order by President at 11:00 A.M.

The minutes of the April 12, 1969 business meeting were declared approved as mimeographed and distributed to the membership.

President DeVall called for reports.

REPORT OF THE SECRETARY (Spencer). Registration for the 1970 meeting reached 268. There were representatives from 54 institutions and agencies exclusive of high schools registered. Summary of Membership was as follows:

Total Membership December 31, 1968.....	997
Total Membership December 31, 1969.....	1068
Net Gain.....	71
Total Membership April 1, 1970.....	1087

REPORT OF THE TREASURER (Arendale).

RECEIPTS		AMOUNT	
Membership Dues		\$4,113.00	
NSF Grants - Indirect Costs		258.62	
Annual Meeting		851.96	
Research Grants		422.00	
Miscellaneous (AJAS Contributions)		2,025.00	
Total		\$7,670.58	
EXPENDITURES		AMOUNT	BUDGET
Publication of Journal	\$2,478.47		\$2,650.00
Postage	6.00		
Honoraria for Editor	500.00	2,984.47	600.00
Assistance to AJAS		2,050.00	2,700.00
Student Awards		50.00	120.00
Research Grants		347.00	400.00
Annual Meetings			
Meals Costs			
Host Institution			
Expenses Net			175.00
Programs		315.00	200.00
Academy of Science			
Award			150.00
Speakers, Officers			
Expenses, etc.			200.00

# Abstracts

	AMOUNT	BUDGET
Academy of Science Assessments	18.80	16.00
Operating Expenses		
Office of the President	125.05	175.00
Office of the Secretary	708.01	600.00
Office of the Treasurer	223.66	220.00
Office of the Editor-Newsletter	33.54	50.00
Office of the Coordinator Science Fairs	100.00	100.00
Office of the Counselor AJAS		75.00
Public Relations Committee		100.00
Supplies	<u>138.00</u>	150.00
Newsletter		100.00
Deposited in Savings Account	<u>244.11</u>	
Total	\$7,339.04	\$8,781.00
Balance in checking account December 31, 1968		\$1,777.40
Total Receipts to December 31, 1969		<u>7,670.58</u>
		\$9,447.98
Total Expenditures to December 31, 1969 including \$244.11 to savings		<u>7,339.04</u>
Balance in checking account December 31, 1968		\$2,108.94
Balance in savings account, December 31, 1968		\$6,623.43
Interest to July 21, 1969		132.46
Deposited July 21, 1969		<u>244.11</u>
Total		\$7,000.00
First National Bank Savings Certificate Issued July 22, 1969		7,000.00
Value of Savings Certificate December 31, 1969		7,088.05

REPORT OF BOARD OF TRUSTEES (Barrett). The Board of Trustees was successful in securing \$2200 from 20 companies and individuals for support of the programs of the Academy.

REPORT OF THE AUDITING COMMITTEE FOR A.A.S. (Hartman). The accounting books of the Alabama Academy of Science have been checked by the Auditory Committee and are correct insofar as could be determined. The treasurer has performed 1,065 transactions during the audit period. Two active accounts are maintained with the First National Bank of Huntsville and the current balance is as follows: \$5,017.62 in the checking account and \$7,089.16 in the savings account with the interest compounded to 22 January 1970.

The Committee wants to commend Dr. W.F. Arendale for the manner in which he is carrying out his burdensome duties as Treasurer of the Academy.

REPORT OF THE AUDITING COMMITTEE FOR THE A.J.A.S. (Furman). The books of the Alabama Junior Academy have been audited and found to be in order.

The books of the National Science Foundation grants to the Alabama Academy of Science have been audited and found to be in order.

REPORT OF COMMITTEE ON PLACE OF MEETING (Hartman). 1. The 1971 meeting will be held April 1, 2, and 3 at the University of Alabama at Tuscaloosa. Dr. H.D. Hays will serve as general chairman. 2. The 1972 meeting will be held April 13, 14, and 15 at Jacksonville State University. Dr. Reuben Boozer will serve as coordinating agent for this meeting. 3. The 1973 meeting will be held at the University of Alabama in Huntsville, with Alabama A & M University and Redstone Arsenal serving as co-hosts. Dr. William Arendale will serve as coordinating agent until the local committee is appointed.

REPORT OF RESOLUTION COMMITTEE (DeJarnette). Your Resolutions Committee submits the following resolutions:

WHEREAS the Alabama Academy of Science is successfully engaged in the Forty-Seventh Annual Meeting on the campus of Auburn University, therefore, BE IT RESOLVED:

- a) That the Academy express appreciation to the officials of Auburn University and to its President, Dr. Harry M. Philpott, for their hospitality;
- b) That special appreciation be expressed to James A. Lyle, Chairman of the Local Arrangements Committee for the Senior Academy, and to Robert T. Gudauskas, Chairman of the Local Arrangements Committee for the Junior Academy, and their co-workers whose untiring efforts contributed in no small way to the success of the meeting;
- c) That the gratitude of the Academy be expressed to H.F. Milling and the Birmingham Division of the Sargent-Welch and Company for their hospitality in acting as co-host for the annual dinner.

WHEREAS during the past year, death has deprived the Academy of the valued services of five members; now, therefore BE IT RESOLVED that the Academy extend its sympathy to the families of RICHARD W. FITZGERALD, Montgomery; EDWIN O. PRICE, Auburn; BRUNO R. ROBERTS, Durham, North Carolina; ARTHUR J. SCAVELLA, Tuskegee Institute; and PATRICK H. YANCEY, Mobile; and express its appreciation for the loyal and valuable services these members have given to the Academy.

It was moved and seconded that the resolutions be adopted. The motion passed unanimously.

The following resolution was offered by Dr. Sam Barker.

WHEREAS most countries of the world, in contrast to the United States of America, use as official the metric system of weights and measures, and WHEREAS the United States is already changing to this system in specific areas such as pharmaceuticals, therefore, BE IT RESOLVED that the Alabama Academy of Science go on record as favoring the official adoption of this system, and that furthermore the Academy urge all science teachers in the public school system of the State of Alabama to incorporate some specific familiarity with the metric system and its interconversion with the inches-pounds system in order that the unfamiliar metric system terms may be more readily understood by the citizens of the state.

The Secretary of the Academy is hereby instructed to send copies of this resolution to the United States Senators and Representatives from the State of Alabama, as well as to science teachers in the State.

It was moved and seconded that the resolution be adopted. The motion passed unanimously.

NOMINATING COMMITTEE (read by President DeVall). See inside front cover.

At this time certain awards and recognitions were made.

Audrey Maxine Logan was presented by Dr. John Holland as the outstanding teacher of the year.

Following the above presentation Miss Mary Beth Upchurch offered the following resolution:

BE IT HEREBY RESOLVED by act of the Alabama Junior Academy of Science on the eleventh day of April in the year one thousand, nine hundred and seventy that:

Auburn University and especially Dr. Robert T. Gudauskas be highly commended for the gracious welcome extended to the delegates and sponsors at the annual convention of the Alabama Junior Academy of Science.

Moved and seconded by Miriam Heaton. Motion carried.

George O. Twellmeyer made the following announcement of the winners of the regional Science Fairs.

Central Region:

Michael Lawrence  
Jan Susina



Mobile Region:	Andrea Patronas Donald Smith
North Region:	Not known at this time. Fair to be on April 17.
Northwestern:	Linda Gale Douglas Rory Waters
Northeastern Region:	Mary Beth Upchurch Charles Kenny Brothers
Western Region:	Whitney Telle Richard Cross

These finalists have won the honor to represent their regions at the International Science Fair to be held in Baltimore, Maryland May 11-16, 1970.

F.J. Stevens announced the winners in student research as:

D.W. Yeager	Shirley Wilkerson
Barry Burgess	Andrew Chase Edwards

These were awarded cash awards and certificates.

William A. Short asked that each Gorgas winner stand as his name was called. Winners were:

Fifth alternate-----Michael Eugene Jones, Opp High School  
Fourth alternate-----Hubert Macon Landers, Jr., Colbert County High  
Third alternate-----Darvin Eugene Morris, Curry High School  
Second alternate-----Patricia Lynn Williams, Austin High School  
First alternate-----Marcia Gail Thrasher, Austin High School  
Fourth award-----Audrey Elizabeth Goins, Springdale High School  
Third award-----Whitney Royce Telle, Tuscaloosa High School  
Second award-----Michael Lynn Griffith, Austin High School  
First award-----Hans Hamilton Liu, Tuscaloosa High School

Dr. Turner Allen of Florence State University was introduced by Joseph Thomas. Dr. Allen spoke on History in Nursery Rhymes.

The meeting was turned over to the new President, Father W.L. Furman. Father Furman announced that the meeting for 1971 will be held at the University of Alabama, Tuscaloosa, on April 1, 2, and 3.

There being no further business, the President adjourned the meeting at 12:00 Noon.

G.O. Spencer, Secretary





6.76, J.A.  
DEC 8 1972

# THE JOURNAL

OF THE

## ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR  
AUBURN UNIVERSITY  
AUBURN, ALABAMA 36830



THE JOURNAL  
OF THE  
ALABAMA ACADEMY  
OF SCIENCE

AFFILIATED WITH THE  
AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE

VOLUME 41

OCTOBER, 1970

NUMBER 4

EDITOR, PRO TEM.

Robert T. Gudauskas  
Auburn University

ARCHIVIST

Clyde H. Cantrell  
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman  
Auburn University

Dan C. Holliman  
Birmingham-Southern  
College

Ann Everett  
Crossville High  
School

*E. L. McGraw, Auburn University, Editorial Consultant*

---

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.



## CONTENTS

### ARTICLES

Economic Models in Regional Research William D. Gunther . . . . .	225
Instalment Lending in Alabama : The Impact of the Truth in Lending Act? William D. Geer . . . . .	232
Alabama's Relative State and Local Tax Burden Charles G. Leathers . . . . .	240
Some Significant Barriers to Space-Technology Transfer Gene Ermert . . . . .	246
Coefficient of Friction of Simulated Lunar Materials Stanley A. Fields . . . . .	250
Return Current Distributions for Improved Stabilization of Pinched Plasmas in Curved Tubes T. G. Roberts and T. A. Barr, Jr. . . . .	254
N-CO <sub>2</sub> Lasers G. J. Hutcheson and T. G. Roberts . . . . .	263
Use of Masonite Samplers in Determining Toxicity Profile in Valley Creek Walter M. Tatum . . . . .	273
Some Little Known Plants in Alabama Blanche E. Dean . . . . .	278
INDEX . . . . .	281

ECONOMIC MODELS IN REGIONAL RESEARCH

William D. Gunther  
University of Alabama  
University

While differential rates of regional economic growth are an integral part of a dynamic and open economy, significant variations between regions can be narrowed through economic planning. To be effective, these plans must be structured within a sound development strategy, and this in turn requires a careful and complete analysis of the region. Economic models can be an extremely valuable aid in the establishment of both an effective development strategy and plans consistent with this strategy.

It is significant to note at this point that there is a major difference between development planning and development plans. Development planning is the process of identifying and establishing goals or objectives for the economy, while development plans are essentially the product of the planning process. Plans become the directives for achieving the established goal or target (7). Implicit in this division is the use of analytical techniques during the planning process to identify and establish relationships between the objective and its determinants. Unless these determinants are understood, effective control will be lost. Economic models are extremely useful at this point, and as such can be an integral part of the planning process.

Stimulating economic growth requires the identification of the important determinants of the region's development. This identification process is the prime task of economic analysis and the researcher-economist must apply such tools of analysis as are deemed applicable to the situation at hand. The choices available depend in large part upon an awareness by the researcher of the scope and limitations of each potential model. Many mathematical models are often excluded from consideration because of a general lack of appreciation of their potential contribution, especially in the area of development planning.

In an effort to reduce this misunderstanding and, consequently, to open the way for increased model use in small area planning, this article describes model building techniques in general, lists some of the advantages of model building, and elaborates on a few of the problems associated with their use. Some comments are also offered on defining and establishing regional boundaries with the use of mathematical techniques.

*Defining the Area of Application*

Any discussion of the use of models as aids to the solution of regional economic problems requires identification of the types of problems encountered in regional economic research. While no universal definition has emerged from the literature, several alternatives are available. The following definition suggests a broad interpretation of certain questions pertinent to regional scientists.

"No fully satisfactory way of classifying regional studies was found -- not unexpectedly. Regional studies tend to deal with many features and often involve the use of

several academic disciplines. Thus, no general system of classification can be expected to provide self-contained categories; there is inevitable spill-over. The subject classification employed in this report sets up categories whose cores, if not boundaries, are identifiable and whose titles are widely used, with popular and technical meanings that are not too far apart. The typical categories employed are: (1) physical elements and natural resources; (2) population and human ecology; (3) regional economic development; (4) metropolitical studies and metropolitan planning; (5) regional history, literature and socio-cultural elements. Two other categories were found necessary: (6) methods and techniques of regional analysis; and (7) comprehensive regional studies" (4).

Little is excluded from this description, yet it seems too broad to provide a working definition for regional economic planning. Also, such a comprehensive list of categories seems to deny the possibility of isolating regional economics as a discipline. Isard (3) defines regional analysis by listing some problems examined in regional studies:

"An analyst is perplexed with many problems when he looks at a region. One problem may be to identify specific industries which can individually or in groups operate efficiently and with profit in the region. Another related problem may be to raise per capita incomes and perhaps achieve a more equitable distribution of income. The auxiliary problem of measurement of income and the performance of society is also present. Still another problem may be to avoid an industrial mix which is too sensitive to the up and downs of national and world business, and which is composed too heavily of old, slow-growing or declining industries; this is the problem of diversification. Finally, a fourth problem which can be mentioned is to plan industrial development for a region, as part of a system of regions, in an internally consistent manner . . . (Another) pressing problem . . . and which for many regions is the most critical, is the problem of how to put to best use a limited if not a niggardly, endowment of resources."

A list of economic problems which may need to be studied in regional analysis can be useful as a technique for delineating regional economics. However, the mere compilation of such a list has little use in determining an analytic description. In a rapidly changing discipline, a list of economic problems is necessarily incomplete, thus not analytically capable of providing a definition (1).

A more generalized definition is needed to give consideration to additional factors necessary for the existence of regional economics. The following definition emphasizes the planning of economic growth:

"Regional economics is, therefore, the study from the viewpoint of economics, of the differentiation and interrelationships of areas in a universe of unevenly distributed and

imperfectly mobile resources, with particular emphasis in application on the planning of the social overhead capital investments to mitigate the social problems created by these circumstances" (1).

First, regional economics is concerned with the economic "differentiation" of areas or regions within the universe or total economy. Secondly, regional economics is concerned with public policy decisions which are capable of mitigating the social problems created by this differentiation of areas. Accepting this definition, analytical tools are needed to examine the various areas and explain, if possible, the cause of differences; to explore the nature of the relationship between regions, and to assist in formulating an appropriate development policy.

### *The Use of Models in Regional Delineations*

Regions are developed for man's convenience and usually for a special purpose. It is not too surprising, then, to find a wide variety of regional boundaries existing in the same general area, each reflecting some homogeneous grouping of such basic units as counties. Homogeneity as used here is a rather broad criterion which allows the same determinant (e.g., homogeneity) to produce numerous regional boundaries. For example, regions can reflect homogeneous political authority (policy regions), homogeneous economic relationships (nodal or functional regions), homogeneous physical and social characteristics (the Appalachian Region) and finally, homogeneous in the availability of basic data (4).

The use of mathematical models during this stage of analysis is primarily concerned with the identification of variables which are significant in explaining the economic growth of the general area. Once these variables have been identified, the researcher can create precise boundaries within which these variables are, to some degree, homogeneous.

As these regions develop, economic ties and other structural changes presumably will occur. This is likely to alter the values and relationships of the variables used to delineate the region's boundaries. Consequently, boundaries should not be considered rigid lines across which economic or social ties are not likely to develop. As new relationships are created, regional boundaries should be re-examined and, if appropriate, altered to reflect these changes. Mathematical models provide an inexpensive method of testing the significance of adding or deleting specific areas from the original regional grouping.

Regional delineations based upon any of the following offer good guides for establishing effective development groups (2):

1. Areas or regions which have similarities of internal determinants of growth. (Natural resources, human resources and local institutions.)
2. Areas or regions which have similarities of external determinants of growth. (Similar patterns of external relationships with the national economy or similar governmental control.)

3. Areas or regions which functionally relate to other parts of the areas in question. This is a somewhat more involved requirement and relates directly to the interdependence of economic activity between two relatively concentrated places because of low transportation costs, economics of location, or both.

Regional boundaries could arise from any of the above three conditions, although it is probably safe to suppose that these boundaries will satisfy two or perhaps three of the conditions. These conditions suggest that in a dynamic national economy capable of radiating growth stimuli in constantly changing patterns, the regional boundaries could be continuously changing. While the prospect of shifting regional boundaries suggests many problems, especially in the continuity of historical data, a compromise between rigidly fixed regions and continuously changing ones seems reasonable.

While many of the mathematical methods useful in these types of applications are in the early stages of development, application of the techniques can provide valuable information for modifying and improving the methods of delineating regional boundaries.

#### *Regional Models and the Size of Regions*

Financial resources available for research in regional development vary with the size of the region. Research sponsored by certain government units is obviously more limited in smaller areas. Subsidies from outside sources to small areas may be constrained when figured on a cost-benefit basis. Moreover, situations in which the generation of new data is required may not be justified due to the high costs of such procedures.

These problems, which seem to become more troublesome in smaller areas, place limitations on what can be realistically undertaken in terms of small area "regional" research. Expanding an area to provide a larger financial base or to create economic rather than political boundaries may not be possible. It may be that the area is both economically and politically consistent and still is not able to generate financial resources sufficient for a large-scale project.

While many analytic techniques as yet are not feasible in small areas, other techniques can be and have been modified to fit the financial constraints of such areas. Regional planners, however, often fail to express an interest in these types of techniques, and they are thus ignored. This lack of interest perhaps reflects a lack of appreciation of the manner in which mathematical models may be useful in regional research.

#### *Requirements of Economic Planning Models*

Mathematical models used in development planning are distinguishable from the vast category of all economic models in that they must meet certain "conditions of practical applicability" (6). Each of the conditions

singularly may not seriously limit a model's usefulness, but in combination such conditions may cause serious trouble. In order to eliminate, at least partially, some of these initial problems, mathematical models should be complete in the sense that they adequately describe the entire economy and do not oversimplify to the point of disregarding significant or vital sectors of the economy. Similarly, mathematical models should adequately and correctly depict the relationships included in the model. These general requirements or conditions are relevant to all economic models, but they bear special consideration for models which may make an immediate impact upon public policy. Some other conditions, acting in combination with the above conditions of practical applicability, are perhaps more crucial to small-area development planning, and may act to reinforce the usefulness of mathematical models in planning an effective development strategy.

Two less technical requirements of models are that they be manageable and understandable by those persons charged with their use. The extent to which any one model is manageable will, of course, depend upon the training of the particular individual working with the model. In general, models will have to be tailored to fit the abilities of the development agency rather than attempting to force a given model into an area. Over the long-run, however, the training of the staff should be raised so that wider choices of models may become available for their use.

Finally, unless the model is understandable to those utilizing the results of its operation, little can be gained from its use. This is not to suggest that the policy maker must achieve the same expertise as the model builder, but implies only that the policy maker should understand the general nature of the type questions which are capable of being answered. This added knowledge will not only aid in the proper interpretation of the model results, but will also serve to keep the model within its operational boundaries.

The model builder can play a vital role by using his ability to accurately and effectively describe the model to the policy maker. Equal responsibility rests with the policy maker in absorbing and assimilating what may seem to be endless assumptions and interrelationships. However, it is also true that effective communication can break down when the complexity of the model places strains on both the builder and the user. What is required, then, is that no model should be unnecessarily complex and presentation should be as intelligent as the builder can develop.

To summarize, the ability of mathematical models to aid in the development planning stage depends upon certain conditions being met: (1) they must be complete in that all important relationships are included, (2) they must be correct to some meaningful degree, (3) they must be manageable by those who use them, and (4) they must be understandable to those who are to develop policy from them. Admittedly, these conditions are somewhat general, and in themselves do not automatically exclude or identify any one particular model for use in development planning. Within these limits, however, the four conditions do indicate the considerations which should be given to the selection and presentation of prospective models to be used in development planning,



particularly in small-area development where the conditions of manageability and understandability are especially critical.

An added constraint on the building and use of quantitative models is that they should be capable of being implemented with a monetary and time expenditure consistent with their usefulness. The construction of models of modest complexity requires the energies of several staff members of an organization. The more complex the problem, the more time will be required in analyzing and constructing an adequate model. Using analytical techniques which have been developed and proven through application to similar problems in the past can greatly reduce development cost. But time will still be needed to adapt this general framework to the local situation. Time and financial resources used in this adaptation are usually significantly less than those associated with the development of new techniques. The ability of an analyst to select existing techniques appropriate to the problem being studied increases the choices of techniques available within the relevant financial constraints.

In the final analysis, the choice of a model is still very much a question of preference. But this choice depends upon a general knowledge of models as well as familiarity with several types of models and their particular scope.

### *Summary*

Differential rates of regional economic growth are an integral part of a dynamic and open economy. The factors responsible for such differences are shifting patterns of supply and demand and the comparative advantage of the various regions. While these differences can be seen as a part of an economic system, wide variations between regions can be narrowed by effective economic planning.

These efforts, however, need to be developed within a framework of a development plan, and this in turn requires a careful analysis of the region's economic limitations and potential growth. Economic models can provide much of the analysis needed to establish these plans.

The present state of economic science leaves many problems of model building as yet unresolved. From a utilitarian point of view, problems of model building should not be allowed to limit the contributions, however meager, of techniques now available. Indeed, it is because decisions regarding regional development must be made, and will be made with or without the aid of such techniques, that they should be utilized.

The adoption of many mathematical models by small areas in the past can be adequately described as a process of "selective absorption" (5). A lag exists, however, between the time a given technique is developed in another, larger region and its absorption by smaller areas. Often this lag is due to the failure of local planners to understand the potential benefits of techniques as well as their limitations.

## Economic Models in Regional Research

### LITERATURE CITED

1. Dubey, Vinod. 1963. The definition of regional economics. J. Reg. Sci. 5:25-29.
2. Hoover, Edgar M. 1957. Problems of assessing regional economic progress: comment. Regional Income 21:63.
3. Isard, Walter. 1960. Methods of regional analysis. MIT Press, Cambridge, Mass.
4. Meyer, John R. 1963. Regional economics: A survey. Amer. Econ. Rev. 53:21-22.
5. Rozen, Marvin E. (ed.). 1967. Comparative economic planning. D.C. Heath and Co., Inc., Boston.
6. Tinbergen, Jan and Hendricus Bos. 1962. Mathematical models of economic growth. McGraw-Hill Book Co., New York.
7. Waterson, Albert. 1966. A hard look at development planning. Finance and Development, June:85-91.

INSTALMENT LENDING IN ALABAMA:  
THE IMPACT OF THE TRUTH IN LENDING ACT?

William D. Geer  
Samford University  
Birmingham, Alabama

*Economic Developments 1961-1968*

The national economy is currently in its 97th month of economic expansion, the longest period of peacetime prosperity in our history. Gross national product (GNP) or the total value of all goods and services produced by the economy totaled \$860 billion in 1968. This represents an increase of \$75 billion over 1967 or an annual growth rate of 9%. Even after adjustment for the increasing rate of inflation of recent months, our real growth was still 5% in 1968.

Reviewing the last eight years, Table 1 shows that tremendous economic progress was made between 1961-1968, inflation notwithstanding. GNP increased from \$520.1 billion in current dollars in 1961 to \$860.0 billion at the end of 1968, an increase of \$340 billion or 65%. GNP expressed in 1958 dollars or after adjustment for price change increased from \$497.2 billion in 1961 to 714.4 billion in 1968, a real increase of \$219 billion or 42%. Table 1 shows other evidences of the prosperity experienced over the period; a 27% increase in real GNP per capita, the sharp reduction of unemployment from 6.7% to 3.3% of the labor force and the rising consumer and wholesale price index.

*Economic Growth in Alabama*

Alabama's economy has reflected the strong growth of the national economy in the last eight years. While GNP figures are not available on a state basis, the impact of the current level of prosperity can be seen by examining the data on personal income in Alabama for the period 1961-1968. Personal income in Alabama increased from \$5 billion in 1961 to \$8.1 billion at the end of 1968 (8). Per Capita income in Alabama increased from \$1,508 to \$2,265, a gain of 61 for the period.

*Expansion of Instalment Credit*

Rapid economic expansion has been accompanied by an even more rapid growth in instalment lending both for Alabama and for the nation as a whole. Instalment loans held by the nation's insured commercial banks increased from \$19 billion at the end of 1961 to \$41 billion at the end of 1968 or an increase of 115%. Instalment loans held by Alabama commercial banks grew from \$227.2 million at the end of 1961 to \$535.8 million on December 31, 1968 for a gain of 136%. This is borne out in Table 2 which shows total instalment loans held by Alabama financial institutions.

As an increasing number of Alabama consumers have moved into higher income brackets they have made wider use of instalment credit. Changes in the age composition of the state's population and the rate of family

TABLE 1. Selected indicators, 1961-1968.<sup>a</sup>

	1961	1962	1963	1964	1965	1966	1967	1968
Gross national product (billion)	520.1	560.3	590.5	631.7	681.2	739.5	785.1	860.0
Gross national product (1958 dollars)	497.2	529.8	551.0	580.0	614.4	647.7	669.2	716.4
Population (million)	183.8	186.7	189.4	192.1	194.6	196.8	199.1	201.0
Unemployment (% civilian labor force)	6.7	5.6	5.7	5.2	4.6	3.9	3.8	3.3
Total GNP per capita	2,705	2,837	2,909	3,019	3,157	3,291	3,362	3,442
Consumer price index (57-59 = 100)	104.2	105.4	106.7	108.1	109.9	113.1	116.3	120.3
Wholesale price index (57-59 = 100)	100.3	100.6	100.3	100.5	102.5	105.8	106.1	107.6

<sup>a</sup>1961-67 figures calculated from: U.S. Congress, Economic Report of the President, 1961-1968. Figures for 1968 estimated.

TABLE 2. Instalment loans held by Alabama financial institutions at year end (in thousands of dollars).

	1961	1967	1968*
Commercial banks - total <sup>1</sup>	<u>227,225</u>	<u>492,360</u>	<u>535,818</u>
Automobile	104,136	251,234	269,562
Other consumer goods	37,805	79,352	98,450
Residential repair & modernization	30,839	33,667	42,511
Personal expenditures	54,445	117,490	117,420
Credit cards and related plans:			
Retail (charge account) credit card plan		9,746	10,125
Check credit and revolving credit plans		871	871
Small loan companies - total <sup>2</sup>	<u>164,752</u>	<u>175,595</u>	<u>185,000</u>
\$300 and under	37,331	37,701	38,000
Loans over \$300	27,421	137,894	147,000
Sales finance contracts <sup>2</sup>			
Handled from office of small loan license <sup>3</sup>	35,524	102,815	105,000
Credit unions <sup>4</sup>	91,952	201,103	221,103
Total - all financial institutions	519,453	971,873	1,046,921

\* 1968 figures have been estimated on the assumption that instalment credit increased in 1968 at the same rate that it increased in the last period for which data is available.

<sup>1</sup> Data includes all commercial banks in Alabama; FDIC Report of Call No. 58, December 30, 1961, No. 82, December 30, 1967 and No. 84, June 29, 1968.

<sup>2</sup> The 1967 Annual Report Of Small Loan Operation State Of Alabama Superintendent of Banks.

<sup>3</sup> This figure does not include the volume of sales finance paper held by some of the larger national sales finance companies.

<sup>4</sup> Credit Union Yearbook, 1962, 68, Credit Union National Association.

## Instalment Lending in Alabama

formations are other factors leading to the greater use of instalment loans. Studies have shown that middle income families and younger families tend to make the greatest use of instalment credit (7).

### *The Small Loan Act of 1959*

Alabama took a big step forward with the passage of the Small Loan Act of 1959. However, this act only regulated loans up to \$300. Table 2 indicates that the volume of loans of \$300 and under made by small loan companies regulated by the Small Loan Act remained almost stable during the period 1961-68. The year end total for loans of \$300 and under ranged from a low of \$35.6 million in 1963 to a high of \$38 million at the end of the period under study.

Loans over \$300 made by small loan companies since 1961 have grown from \$27 million to a year end total of \$147 million in 1968. Total sales finance contracts handled by small loan companies increased from \$35 million at the end of 1961 to \$105 million at the end of 1968. These last two classes of loans representing an increase of \$190 million since 1961 are not subject to regulation by the Small Loan Act. It is common knowledge that such loans are made at rates in excess of the existing legal instalment loan rate of 6%.

Data provided the State Banking Department by small loan companies would seem to indicate that the Small Loan Act is not providing the protection to consumers that the legislature intended.

### *Total Instalment Credit In Alabama*

With instalment credit held by credit unions in Alabama advancing from \$91.9 million in 1961 to \$221.1 million at the end of 1968 the total amount of instalment credit held by financial institutions in the state on December 31, 1968 stood at \$1,046,921,000 (Table 2). It should be noted that this figure does not include data on some national sales finance companies.

Exact figures on instalment credit held by retail outlets are not available for a recent date. However, these figures can be reasonably estimated at \$186 million by projecting studies made by the Federal Reserve System. If this figure is added to the \$1,046,921,000 in instalment credit held by financial institutions in the state, total instalment credit in Alabama on December 31, 1968 comes to \$1,232,921,000.

### *Instalment Loan Rates*

The current practice of stating instalment interest charges does not clearly indicate the true simple annual rate. As a rule of thumb a close approximation of the simple annual interest rate may be obtained by doubling the stated rate on most instalment contracts. The reason for the difference in the stated rate and the simple annual rate results from the fact that on instalment contracts the interest is added to the amount borrowed which is then divided into a series of monthly payments. For example, on a \$1000 loan extended for one year at 8% interest, \$80 would be added to the amount borrowed, and the \$1,080 would be divided



by 12 to obtain monthly payments of \$90 each. Since the loan is repaid in monthly payments the borrower only has the use of an average of \$545 (\$1,000 + \$90.00 divided by 2). Thus it can be seen why the simple annual rate or true rate is approximately twice the stated rate.

A more precise method of determining the approximate true annual rate of interest is to use the constant-ratio method which makes use of the following formula (3):

$$R = \frac{2 \text{ mi}}{P(m + 1)}$$

where R equals the annual rate charged; m equals the number of payment periods in one year (12 if you are repaying monthly; 52 if you are repaying weekly); i equals the true dollar cost of credit; P equals the net amount of the balance to be paid; and n equals the number of installment payments you will make.

Applying the constant-ratio formula to the above example the following result is obtained:

$$R = \frac{2(12 \times \$80)}{1000(12 + 1)}$$
$$R = \frac{1920}{13000} = 14.77\%$$

#### *Structure Of Interest Rates*

Frequently the difference between business loans and instalment loans to consumers are not clearly understood, and the question arises as to why financial institutions charge different rates of interest on the two types of loans. A brief summary of the structure of interest rates will explain why interest rates on instalment loans are usually higher than interest rates on business loans.

The interest rate charged by any lender is made up of three elements.

- A. Pure Interest Rate: The price paid for the use of money not including the compensation for financial risk or for any other disadvantageous characteristics of the loan.
- B. Financial Risk: The price which the lender must receive for assuming the risk connected with the borrower's ability to repay the loan.
- C. Cost of Servicing the Loan:
  1. Acquisition Cost which is the cost of placing the loan on the lender's books, interviewing the applicant and appraising his ability and willingness to pay.
  2. Liquidation Cost which is the cost of servicing and collecting the loan once it is on the books.

The pure rate of interest is usually taken to be the rate of interest currently being paid on 90 day government bills. On February 14, 90 day

## Instalment Lending in Alabama

bills were yielding 6.24% (6). At the end of 1961, short term bills were returning only 2.61% (2). This shows that the basic cost of money has increased about 2½ times in the last eight years.

It should be noted that the pure rate of interest is the same for any type of loan of the same maturity. It is the difference in the financial risk and the cost of servicing a loan that accounts for the difference in interest rates. If consumers are to be provided with the convenience of instalment loans, interest rates must be sufficient to cover the increased financial risk and the higher cost of servicing this type of loan.

### *Instalment Loan Legislation In Alabama*

Alabama is one of the few states not having fully developed instalment loan legislation (4). Most other states have passed instalment loan acts in an effort to bring their codes into line with changing economic conditions. Title 9, Section 61 of the Alabama Code as amended in 1953 legalizes a 6% per year add-on rate for instalment loans. This law made it possible for banks and other lenders to make many types of instalment loans legally, but the steady increase in the cost of money to all lenders since 1953 has resulted in a greater amount of instalment lending in Alabama being made at rates in excess of the 6% legal rate.

### *Impact Of The Truth In Lending Act*

When the Truth In Lending Act goes into effect on July 1 the actual rates charged by instalment lenders will be made clear to many consumers for the first time. The Act requires that the finance charge be stated as a simple annual rate or true rate. If the existing Alabama instalment loan law with its add-on rate of 6% or approximately 11.5% when stated as a simple annual rate were strictly enforced, the volume of instalment credit in Alabama could be drastically reduced. This would result in economic hardship not only to instalment lenders, but to consumers who have come to depend on instalment credit to support their present standard of living. But more importantly the general economy of the state would suffer extensively by the reduction in consumer spending power.

A very large percentage of the total instalment loans held by Alabama financial institutions as shown in Table 2 were made at rates in excess of the 6% legal rate for instalment loans. Loans made by national finance companies to finance used cars are currently being made at add-on rates of from 7 to 14%. Thus, true annual rates range as high as 25%.

Loans made by small loan companies in amounts exceeding \$300 and sales finance contracts made by these companies are made at rates that range from 24 to 30% when expressed on a true annual basis. Generally both national sales finance companies and small loan companies appear to charge rates in line with those permitted by law in other states. This was found to be the case in a study made several years ago by the State Banking Department.<sup>1</sup>

---

<sup>1</sup>Personal communication, Alabama State Banking Department, March 5, 1964.

Most types of revolving credit plans made by department stores and banks are made at monthly rates of  $1\frac{1}{2}\%$  per month. This is approximately 18% when expressed as an annual rate which is required by the "Truth in Lending Act." These rates are also in line with rates charged in other parts of the country for this convenience type instalment loan service.

To require that revolving credit plans and instalment credit used to finance consumer durables and used cars be extended at lower rates of interest would result in (1) denying this service to many consumers and (2) an increase in the retail price of goods and services purchased using instalment credit.

Lenders would have to become much more selective to reduce the amount of bad accounts, and the loss of income on the finance charge to consumers would probably be recovered by higher retail prices. Recent studies in the State of Arkansas (1) where the charge on instalment loans is restricted to a 10% simple annual rate support this argument. With the strict enforcement of the Arkansas law over the last 10 years, it has been discovered that the prices of household appliances in Little Rock tend to be higher than in Memphis, Tennessee; Tulsa, Oklahoma; Texarkana, Texas; Monroe, Louisiana; Greenville, Mississippi; Springfield, Missouri; or Denver, Colorado. Lynch (9) found in a recent study of appliance prices that prices in Little Rock were higher than in all other cities studied. He stated, "Average cash prices, compared with a price of \$100 in Little Rock, ranged between \$92.60 and \$97.05 in the seven other cities."

Lynch believed that the major cause of the price differential was the fact that retailers in the states surrounding Arkansas assessed average finance charges of 1.5% per month on instalment accounts while Arkansas retailers were limited by law to a rate of  $\frac{5}{6}$  of 1% per month. He contends that since finance charges in Arkansas did not cover the cost of making instalment loans retailers made up the difference by raising the price of appliances. To the extent that cash prices include part of the costs of credit, consumers who pay cash are subsidizing those who buy on credit. Also consumers who know of the price differentials may shop outside the state to the detriment of the Arkansas economy.

Unrealistic instalment loan rates in Arkansas have had the additional effect of limiting the credit operations of sales finance companies and large national retail outlets in the state. Officials of Sears, Roebuck point out that since 1957 there has been only one new Sears store opened in Arkansas while 100 new stores or relocations and expansions have occurred in other parts of the southeast.<sup>2</sup>

#### *Need For Realistic Instalment Loan Legislation In Alabama*

Instalment loan laws in Alabama need to be brought into tune with the times. Legislation is needed that will provide an interest rate structure flexible enough to permit meeting the needs of consumers. Rates must be high enough to allow lenders to earn a reasonable return on their investment or instalment loans will not be available to consumers within the protection of the law.

---

<sup>2</sup>Personal communication, Sears, Roebuck Legal Department, Atlanta, Ga., February 9, 1969.

## Instalment Lending in Alabama

Currently, credit unions because of their low cost of operations resulting from subsidies from the state in the form of tax concessions and various benefits received from industry are the only instalment lenders that can operate completely within the existing law.

The main thrust of the Truth In Lending Act is to provide consumers with a standard yardstick by which to compare the cost of instalment credit. Once all instalment lenders are required to state instalment rates on a uniform basis consumers will be in a position to shop for credit. However, it must be remembered that not all consumers have the same bargaining power or that the risk and cost of making certain types and sizes of instalment loans vary. It is important that rates be flexible enough to serve the various sectors of the instalment loan market by the different financial institutions that have developed to serve the peculiar needs of various consumer groups.

In establishing rate ceilings, it is not intended that these ceilings serve as a device for generally replacing the free workings of the market with an authoritarian credit pricing system. Rate ceilings should serve as protection against abuses and not as a means of eliminating competitively determined prices.

New instalment loan legislation is urgently needed if Alabama is to continue to experience strong economic growth.

### LITERATURE CITED

1. Arkansas Gazette, October 27, 1968.
2. Board of Governors Of The Federal Reserve System. 1962. Federal reserve bulletin, April.
3. Cohen, Jerome B. and Arthur W. Hanson, 1964. Personal finance: Principles and case problems, Richard D. Irwin, Inc., Homewood, Ill.
4. Geer, William D. 1963. Problems in the development of instalment lending by Alabama commercial banks. D.B.A.Thesis, Indiana University
5. Lynch, G. C. 1968. Arkansas Democrat, Fayetteville, October 13:14B.
6. Manufacturers Hanover Trust Company. 1969. Financial Digest. February 14.
7. Survey Research Center. 1962. 1961 survey of consumer finances, pp. 45-46, University of Michigan.
8. U. S. Department of Commerce. 1968. Survey of current business, August: 14-15.

ALABAMA'S RELATIVE STATE AND LOCAL TAX BURDEN

Charles G. Leathers  
Department of Economics  
University of Alabama, University

INTRODUCTION

The tax burden imposed upon the nation's taxpayers by all levels of government in absolute dollar terms has been steadily increasing during recent years, consequential to the rising demands for public services. Generally, taxpayers tend to feel that they bear a heavier burden than those in other localities. The objective of this paper was to determine the relative weight of state and local taxes in Alabama, and to focus some attention on the changes in that relative burden during the past few years.

The term *tax burden* is quite similar in concept to the term *tax effort*. Basically, a relationship is implied between the ability of the collective body to support the fiscal operations of the governing body, and the actual extent to which public fiscal demands are made upon that ability. While in the very short run it would be theoretically possible for the government to acquire all the resources comprising the tax base, in a more realistic sense no absolute limit has been specified as the ultimate extent to which taxpayers can continually sacrifice without collapsing under the strain. Hence, a more meaningful approach to studying the problem of tax burden is to compare the tax burdens borne by taxpayers in several states.

Several methods will be used in this paper to compare Alabama with eight other states in the same geographical region: Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. This group of states will be referred to as the Southeastern states. In addition to comparing Alabama's state and local tax burden with those in other regional states, Alabama's burden will also be compared with the national average state and local tax burden. The years selected for comparison are 1958 and the latest year for which comparable reliable data are available.

Perhaps the term *tax burden* is a poor choice of words, as it seems to imply an absence of benefit received. This, in most instances, is not true in a collective sense. The most suitable index of tax burdens would be one incorporating the relative benefits received such that the comparisons would indicate returns on public investment as well as inputs of tax revenue. Unfortunately this approach would create problems of quality comparisons of public goods and services. Therefore, in this paper three traditional indicators of relative tax burden or effort are utilized: (1) comparisons of per capita taxes paid; (2) comparison of per capita taxes as a percentage of per capita personal income; and (3) comparison of the index of tax effort.

PER CAPITA TAXES

The simplest way to determine the relative tax burden is to compare dollar amounts of taxes paid per year by the average taxpayer, under the



## State and Local Tax Burden

assumption that dollars paid in taxes have constant and uniform marginal utility (every dollar represents the same amount of sacrifice for each and every taxpayer). Two types of per capita taxes are compared: (1) per capita state taxes; and (2) per capita state-local taxes.

*State taxes per capita.* Between 1958 and 1966, Alabama's per capita state tax rose from \$73.77 to \$131.65 (Table 1). This moved Alabama from 9th place in 1958, regionally, to 7th place in 1966. In the meantime, the difference between Alabama's per capita state tax and the national average per capita state tax rose from \$15.26 to \$18.95. The gap between Alabama's per capita state tax and Louisiana's, the highest-ranking regional state, remained at about \$50. Despite moving up several notches in regional rankings, in 1966 Alabama was only about \$7 above the per capita figure for the lowest state in the region--Mississippi.

*State-local per capita taxes.* The inclusion of local taxes in the comparison of per capita taxes leaves the situation relatively unchanged. In 1958, Alabama's state-local taxes per capita were \$102.68, and by 1966 had risen to \$181.73 (Table 1). This represented a move in relative regional ranking from 9th place in 1958 (last place) to 8th place in 1966 (next to the last place). The gap between Alabama's per capita state-local taxes and the national average rose from \$72.66 in 1958 to \$107.97 in 1966. The differential separating Alabama and Florida, the highest in the group, remained at approximately \$69.00 in 1966.

### PER CAPITA TAXES AS A PERCENTAGE OF PER CAPITA PERSONAL INCOME

Generally, it is considered more meaningful to compare the ratios of taxes paid to the ability to pay when making relative comparisons of tax burdens. A frequently used gauge of tax ability or capacity is per capita personal income. In this respect, an indication of relative tax burdens can be gained by comparing the ratios of per capita taxes to per capita personal income on a percentage basis.

Alabama's average state taxpayer contributed to the state in taxes the equivalent of 5.4% of his personal income in 1958 and 6.4% in 1966 (Table 2). In this respect, his burden was somewhat heavier than the nation's average state taxpayer, who contributed 4.3% of personal income in 1958 and 5.5% in 1966. Alabama's percentage figure rose by the same number of percentage points as did the national average, remaining about 1.0 percentage point above the national average. As compared to his fellow average taxpayers in the other eight regional states, the Alabama taxpayer had the lightest burden in 1958, ranking 9th, and 6th in 1966. Also, in 1966 Alabama was farther from the top of the group than from the bottom.

The average state-local taxpayer in Alabama in 1958 paid taxes amounting to 7.6% of his personal income, which was not only the lightest such tax load in the region, but was also significantly below the national average of 8.5% (Table 2). In 1966, the percentage figure for Alabama had risen to 8.8%, still below the national average of 9.8%, and tied with South Carolina for next to the lowest in the region (two states--Georgia and Tennessee--tied for the lowest position). In contrast, two regional states had percentages exceeding 10.0%--Louisiana with 10.8 and Mississippi with 10.4%.



## INDEX OF RELATIVE TAX EFFORT

Perhaps a more suitable measure of the relative tax burden is the *tax effort index* approach, which utilizes three indexes: (1) an index of tax ability, (2) a tax index; and (3) a tax effort index.

TABLE 1. Per capita state and state-local taxes in nine Southeastern states: 1958 and 1966.

State	<u>Per Capita State Taxes</u>		<u>Per Capita State-Local</u>	
	1958	1966	1958	1966
Alabama	\$ 73.77	\$131.65	\$102.68	\$181.73
Arkansas	79.59	135.46	112.46	187.30
Florida	103.28	137.88	171.45	250.90
Georgia	84.27	137.20	126.45	205.95
Louisiana	124.00	182.78	166.56	245.24
Mississippi	75.63	123.51	111.21	184.18
North Carolina	83.92	155.38	115.65	207.28
South Carolina	78.05	138.40	103.99	180.84
Tennessee	78.28	123.86	122.02	193.19
Nation	\$ 88.03	\$150.60	\$175.34	\$289.70

Sources: Compendium of State Government Finances; Governmental Finances

The tax ability index, which indicates the relative ability to pay taxes, is composed of three component indexes, each equally weighted: (1) a per capita retail sales index; (2) a per capita personal income index; and (3) a per capita economic output index. Each index is calculated by dividing the per capita figure for the state by the per capita figure for the national average, multiplied by 100. Hence, the national average index number is always 100.0. The arithmetic mean of the sum of the three indexes is the tax ability index.

Alabama's tax ability is relatively small, and failed to expand by any substantial degree between 1958 and 1965, relative to expansion in the tax abilities of the other regional states. Not only was it far below the national average--69.2 in 1958 and 73.9 in 1965--but relative to the other regional states it was quite low, ranking 6th in 1958 and 8th, 1965. In both years, Alabama's ability index fell below the average for the region, although some small improvement was registered for both

# State and Local Tax Burden

Alabama and the region relative to the national average. The relatively weak tax capacities of the Southeastern states is demonstrated by the fact that in 1958 none of the regional states had ability index numbers as high as the national average, and in 1965 only one--Louisiana--exceeded the national average.

TABLE 2. Per capita state taxes and state-local taxes as percentage of per capita personal income for nine Southeastern states: 1958 and 1966.

State	Per Capita State Taxes as Percentage of Per Capita Personal Income		Per Capita State-Local Taxes as Percentage of Per Capita Personal Income	
	1958	1966	1958	1966
Alabama	5.4%	6.4%	7.6%	8.8%
Arkansas	6.5	6.7	9.2	9.3
Florida	5.5	5.3	9.1	9.6
Georgia	5.7	5.8	8.5	8.7
Louisiana	8.4	8.0	11.3	10.8
Mississippi	7.2	7.0	10.6	10.4
North Carolina	6.1	6.8	8.4	9.1
South Carolina	6.4	6.7	8.5	8.8
Tennessee	5.4	5.6	8.5	8.7
Nation	4.3%	5.5%	8.5%	9.8%

Sources: Compendium of State Government Finances; Governmental Finances; and Survey of Current Business

Alabama was quite low on all three component indexes from which the tax ability index is calculated. Relative to the national average, Alabama has a bit more strength in economic output and retail sales than in income, but the difference is rather small. Relative to the region, Alabama has greater strength in economic output, but again, the difference is quite small. No change in the relative importance of the three component indexes was indicated between 1958 and 1966.

The tax index is calculated by dividing the state per capita tax figure by the national average, multiplied by 100. The tax effort index is then found by dividing the tax index by the tax ability index, multiplied by 100.

Alabama's state tax index ranked 9th in the region in 1958 (last place) and 6th in 1965. In both years, the state tax index was well below the national average. Alabama's state *tax effort index* in 1958 was 8th highest in the region, and 6th highest in 1965 (Table 3). In both years, Alabama was substantially above the national average by about the same number of points. As a matter of fact, all of the Southeastern states ranked above the national average on the state tax effort index for both years.

Alabama's state-local tax index in 1958 ranked 9th (last place), and 7th place in 1965 (Table 3). In both years, the index for Alabama was less than two-thirds the national average. On the state-local tax effort index, Alabama ranked well below the national average--84.7 in 1958 and 85.3 in 1965. In relation to the regional states, in 1958 Alabama's state-local tax effort or burden was 9th, but rose to 5th in 1965. However, it should be noted that in 1965, the degree of variation was less, and moreover, Alabama was much closer to the bottom than the top of the group in terms of tax effort index numbers.

TABLE 3. Index of tax effort for nine Southeastern states: 1958 and 1965

State	<u>State Tax Effort Index</u>		<u>State-Local Tax Effort Index</u>	
	1958	1965	1958	1965
Alabama	121.1	119.8	84.7	85.3
Arkansas	137.6	111.1	97.6	80.9
Florida	135.9	120.2	113.3	108.4
Georgia	130.4	115.5	98.2	89.0
Louisiana	169.7	133.5	114.5	91.5
Mississippi	157.0	137.0	115.9	103.1
North Carolina	124.4	122.8	86.2	84.0
South Carolina	135.0	120.6	90.3	81.0
Tennessee	119.7	101.3	93.7	81.4
Nation	100.0	100.0	100.0	100.0

Sources: Calculated using data obtained from the Statistical Abstract of the U. S.; Sales Management; Compendium of State Government Finances; and Survey of Current Business

## State and Local Tax Burden

### CONCLUSION

Evidence points to a relatively small ability to pay taxes in Alabama, and no significant change in this relative ability occurred between 1958 and 1965. However, evidence also indicates that Alabama's relative state and state-local tax burden has exhibited, at most, only a modest increase since 1958, continuing to remain relatively low in comparison to tax burdens borne by residents of other regional states. A word of caution is due at this point. The above data are for average tax burdens and in no way indicate how those burdens are distributed among income and wealth groups.

SOME SIGNIFICANT BARRIERS TO SPACE-TECHNOLOGY TRANSFER

Gene Ermert  
Athens College  
Athens, Alabama

Space technology, as used in this paper, refers to new technology developed by federal government research and development programs in the space industry. New technology is broadly defined to include inventions, innovations, improvements, and discoveries originally developed for primary application in the space program. Secondary application of space technology to private industry and other public programs through a technology transfer process is essential.

What is the purpose of technology transfer as an objective of the federal government? Technology transfer has as its purpose the application of existing science and engineering knowledge to private industry and other public programs. This study relates to the storehouse of transferable knowledge existing in the space program. Such knowledge with potential secondary utilization is also available in the Department of Agriculture, Atomic Energy Commission, and other government agencies, which knowledge the federal government is also attempting to transfer to the private sector. Technology transfer is the use of knowledge to serve a purpose other than the primary one for which the research and development was taken.

Technology transfer can also be defined as the process by which the use of technology is diffused throughout society (1). Medical science, communications systems, and other areas, have been advanced by spin-offs from the space industry. A significant socioeconomic impact has been manifested. The use of technology must achieve optimum diffusion throughout society to help solve other social and economic problems. Technology transfer also can be defined as the conscious process by which new knowledge is made available to others than those who generated it (2). As it relates to this study, technology transfer refers specifically to the transfer of government-sponsored research and development technology from space program that has possible applications in the industrial and commercial sectors of the economy.

Why doesn't private industry absorb new technology developed by federal government research and development programs where applicable? Based on exhaustive research of prominent American firms, primarily space-program contractors, some barriers to technology transfer were discovered which will partly explain significant barriers to adoption of new technology or "spin-offs" developed by federal government research and development programs. These barriers also explain some reasons for non-adoption of any new technology irrespective of its source of origin. The findings of this study were derived as a result of mailed questionnaires and personal interviews with firms in space industry. Implications of each barrier will also be discussed with suggestions for improving technology transfer.

Devising means of channeling new technologies in promising directions--and bring about the utilization of new technology for significant purposes

## Barriers to Space-Technology Transfer

other than the immediate use for which it was developed--has become an activity ranking among the most intellectually challenging of our time (4).

Irrespective of source of knowledge about new technology, application of creative ideas is limited in most firms as indicated in current research. As a deterrent to the technology transfer process, technical men, such as design personnel, who are provided a source of ideas are sometimes apparently restricted in their adaptive efforts to apply new knowledge to current design requirements, or use to solve other problems, even though otherwise the application of knowledge could lead to a constructive impact in society and in their firm. How is the designer restricted? Apparently the organizational framework is not designed to permit the ready inflow and acceptance of technology generated by government R and D. As a major barrier to adoption of innovations, reluctance of management to adopt new innovations was also evident in current research. Why is management reluctant and creativeness discouraged?

Dr. Charles Kimball, writing in Research/Development, states that the barriers to the transfer of technology may be categorized into four major areas (4):

1. within corporate management - an unwillingness to take risk, the absence of adequate mechanisms to deal with all the implications of new products and new processes, an unwillingness to render existing plan and equipment obsolete by adoption of the new, a concentration on the short term rather than the long term and lack of knowledge of the government sources of new technology;
2. within the scientific community - the Ph.D. who cannot communicate his findings or who has little economic understanding or drive, the inability to distinguish between the transfer of information and the transfer of documents, the confusion between publication and communication, the orientation of some scientists who seem to regard research as a privileged way of life, and the scientists inadequate appreciation of managements skills and functions;
3. in institutional factors - lack of rapport between industry and universities, the unwillingness of some academics to relate their research to the needs of industry, the geographical separation of the generators of new technology from those who could employ it;
4. within the human mind itself - creativity is generally thought of as an essentially individual endeavor but American society has moved in such ways that most things are done in groups. We have not yet learned how to provide the climate that fosters creativity, and there is a need for more people to become innovation prone.

As indicated in many situations, firms and industries in the private sector are sufficiently competent to adopt space technology. There is



supporting evidence to prove that firms and industries have the capacity to effect innovation evolving from the space program and the ability to generate the technical basis for it (1). Utilization of new innovations is practiced where significant barriers are not prevalent.

Some difficulties in the transfer process have stemmed from reasons other than ineffective communicators, or couplers, or the lack of creative ability or resources in firms, as indicated in current research. Even though creative genius and executive decision-making look favorably upon an innovation from space technology, barriers to utilization within the firm prevent its acceptance. The barriers to acceptance may or may not be outside the arena of responsibility of those individuals and institutions attempting to absorb information about space technology. From the view of the communicator, invention alone is not enough. Given an invention, and awareness of it on the part of a potential adopter, substantial obstacles to innovation may still remain and deter the technology transfer process.

A major barrier discovered in current research apparently involved in-house problems, including reluctance of management to accept new technology. Some firms are set in their ways and either rely on other than space technology resources or do not really want to incorporate new or changed technology in their products or processes at all (3). A possible reason discovered in current research was the amount of time required for conversion and change to documentation, which are complex problems.

As a barrier to adoption of space technology, some firms prefer to rely on in-house developments of new technology. Outside ideas are often crowded out of realistic consideration by the champions of in-house ideas (3). The current research indicates that in-house development may be desired in that outside suppliers are unable to meet quality requirements.

Government restrictions, specifically the lack of military specifications, for some innovations, were cited by some respondents as being a barrier to transfer. These restrictions greatly hamper those individuals engaged in design work or who deal with government contracts. Such specifications are a guideline in decision-making. Some innovations cannot be immediately utilized because of not having a military specification until a later time.

Apparently, the principal barrier to transfer, as it related to some innovations with potential secondary utilization, was the apparent incompleteness of some new technology. As an example, research showed that the majority of respondents in some manner for some reason visualized incompleteness. This can possibly be defined as a constructive impact. Subsequent feedback about incompleteness can stimulate new technology to remove the incompleteness. As an example of incompleteness firms in some cases reported that some innovations were not adopted because of in-house incapability to design suitable cable support and routing. A lack of completeness can stimulate new technology such as the subsequent design of such cable support and routing.

## Barriers to Space-Technology Transfer

In the dissemination of information about new technology, the effect of visualization of incompleteness for various reasons by potential users can be reduced. Possibly, traditional methods of transferring knowledge of new technology, such as technical conferences, journals, and other media, should seek to improve their communicative facility to eliminate lack of optimum impact. Since some media are more preferred, such media have established seekers of new knowledge about new technology. From the viewpoint of the receiver, or the potential user, awareness of incompleteness could initiate a solution to provide completeness. The potential user must have the creative ability and be sufficiently motivated by the potential rewards of increased market demand for products or services created with the use of a new innovation. How can the potential user be motivated and creativeness encouraged? Presence of static in the communication process of traditional media is a significant factor causing lack of optimum transfer impact.

To minimize static and to provide an image of completeness in the dissemination of knowledge process, whatever parts of the knowledge, regarding the new innovation, which appear useful, should immediately be brought to the attention of potential users. Seemingly unrelated pieces originating in separate areas should be fitted together, prior to attempting dissemination, which will more likely maximize effectiveness of impact on the potential user. It is suggested that possibly the bits and pieces of data and information related to a new innovation might be assembled in a "state-of-the-art" publication. Good technical judgment based on demands from the users can select the areas for emphasis in assembling this information from many sources.

Possibly a panel of technically-oriented men should screen innovation knowledge before attempts to disseminate to potential users. Prior to dissemination, by whatever medium, knowledge should be assembled in its "wholeness" or "completeness" so as to meet predetermined, defined needs, and also to provide a source of creative ideas.

### LITERATURE CITED

1. Bauer, Raymond A. 1969. Second-order consequences: an essay on the impact of technology. M.I.T. Press, Cambridge, Mass.
2. Congress, U. S. 1966. The prospects for technology transfer. Senate Subcommittee on Science and Technology to the Select Committee on Small Business, 90th Congress, 2nd session, May 1.
3. Culbertson, John. 1967. Whatever happened to space spin-offs? Calif. Management Rev., Winter:38.
4. Leshner, Richard and George Howick. 1966. Assessing technology transfer. NASA Publication SP-5067, P.S., Washington.

COEFFICIENT OF FRICTION OF SIMULATED LUNAR MATERIALS

Stanley A. Fields  
George C. Marshall Space Flight Center  
Huntsville, Alabama

INTRODUCTION

This report discusses the analytical and experimental investigations used to determine the coefficient of friction between various metal surfaces and granular non-metallic materials. These tests were carefully controlled to ensure that any change in the coefficient of friction from air to vacuum could be attributed solely to the environment. The vacuum system was oil free, being roughed pumped with the sorption technique and a turbo-molecular pump followed by ion pumps. The complete system including the test fixture was bakeable at 250 C.

TEST EQUIPMENT

The friction measuring apparatus is shown in Figure 1. The fixture was designed so that test surfaces could be separated during pumpdown and bakeout to allow outgassing of both surfaces. Surfaces were moved together before the rotation began and a normal load was applied and held constant during the rotation of the metal disk. Separate heating elements permitted outgassing of either the metal disk or the mineral powder, or both specimens simultaneously.

The granular sample was placed in a container 2-3/8 in. in diam. and 3/4 in. deep with the upper edge bent outward to prevent friction between the outer rim of the disk and the powder. Weights of the granular specimens were 65.6 g for the coarse and fine basalt and coarse quartz and 53.6 g for the fine quartz.

Diameters of the metallic disks were 1-1/2 in. with a cross-sectional thickness of 0.025 in. The surface finish on all metal disks was less than 6  $\mu$  in. The disks were driven through a positive drive rotary seal by a motor located outside the vacuum chamber.

A strain gauge balance was used to measure the axial and torsional forces. A diaphragm section above the center of the unit was instrumented to measure axial loads and a thin-walled vertical cylindrical member instrumented to measure torsional forces. Normal forces were measured by means of a two active arm bridge and torsional forces by means of a four active arm bridge.

The vacuum system for the friction test was designed for operation in the 10<sup>-10</sup> torr range with the test fixture and sample inside the chamber. The chamber was rough-pumped with liquid nitrogen-cooled sorption pumps and a Welch turbo-molecular pump. Fine pumping was accomplished by an ion pump and a titanium sublimation pump with a combined pumping speed of approximately 700 liters/sec. When the pressure approached the ultimate value, a helium cryopump was activated. The system, test fixture and sample were baked during the pumpdown cycle to outgas the various components.

## Friction of Simulated Lunar Materials

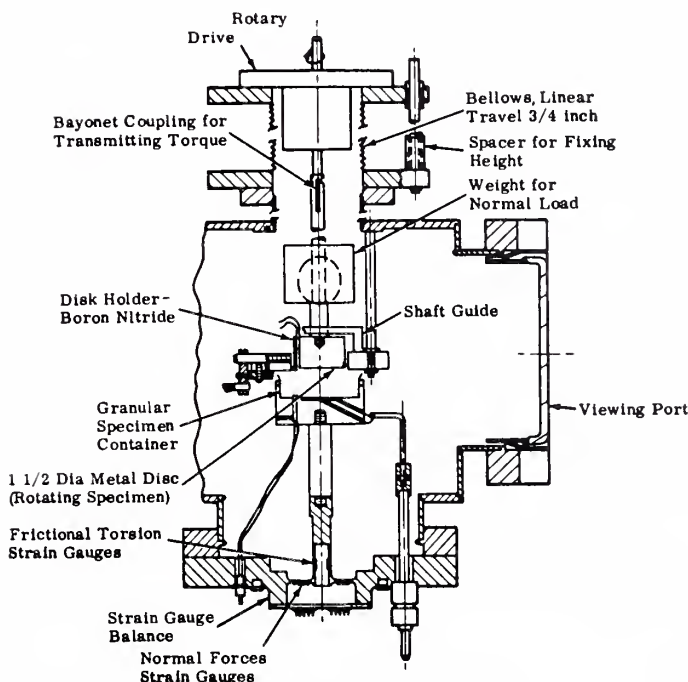


FIGURE 1. Friction measuring apparatus.

### TESTING PROCEDURE

Quartz crystals from Hot Springs, Arkansas and basalt from Somerset County, New Jersey were crushed and sifted to obtain the following size ranges: (1) coarse particles 250-500  $\mu$  in diam., (2) fine particles 38-62  $\mu$  in diam.

Metal disks were machined from aluminum 7075 and steel 1020. After the machining, disks were polished, checked for concentricity, and the finish measured to ensure that it was below six  $\mu$  in. Disks were then cleaned and stored for later use.

A new metal disk and granular sample were used in each test. Earlier tests had indicated that the coefficient of friction increased with increased use of the two samples. The granular sample was placed in the container and positioned on the test fixture. A metal disk was positioned on the test fixture above the granular sample. For a vacuum test, the two samples remain separated and the pumpdown started. The samples and system were baked during the pumpdown and allowed to cool to ambient temperature before conducting the test.

When the acceptable pressure level had been obtained, the following procedure was used to measure the coefficient of friction:

1. The calibration of the strain gauge amplifier and recorder was checked.
2. The speed of the rotating disk was checked.
3. The 2.5 lb loaded, stationary disk was then lowered to rest on the powder for 5 min.
4. The disk was rotated at 3 rpm for 1 min. in a clockwise direction.
5. The disk was raised.
6. The calibration of the strain gauge instrumentation was rechecked.

At the completion of each test, the surface of the disk was examined and its finish measured again. After some vacuum tests, strong adhesion of mineral powders on the contact surface of the disk was observed.

#### RESULTS AND DISCUSSION

Output of the strain gauge amplifier generally resulted in a high initial torque followed by a cyclic lower torque. The initial value was only slightly higher for the tests performed in air and in most instances significantly higher for the tests performed in ultrahigh vacuum.

Torque values representative of the initial condition and the continued rotation were read from the strip chart. The coefficient of friction was computed from these torque values by the formula:

$$\mu = \frac{3T}{2WR}$$

where

$\mu$  = coefficient of friction

$T$  = torque in in.-oz

$W$  = load in oz

$R$  = radius of disk in in.

The average calculated values for the coefficient of friction from two tests are presented in Table 1. The coefficient of friction was higher, both for the initial value and the dynamic value, in vacuum than in air. However, the increase was not as large as might be expected in the  $10^{-10}$  torr environment.

The coefficient of friction between the metal disks and the powder soils tested increased in vacuum over air for all samples. There was an initial coefficient of friction which was higher than the dynamic coefficient of friction. These values are significantly different in vacuum.

# Friction of Simulated Lunar Materials

The coefficient of friction between aluminum 7075 and the granular samples was higher in atmosphere than between steel 1020 and the granular samples. The coefficient of friction was greater between steel 1020 and the granular samples in a vacuum of  $10^{-10}$  torr than it was between aluminum 7075 and the granular samples. The only exception was for one test on coarse quartz.

The initial value of the coefficient of friction was high probably because of an adhesion bond between the metal disk and the granular sample. Additional analyses in this program and a related one are expected to result in a better understanding of this phenomenon.

## ACKNOWLEDGMENTS

These investigations and analyses were conducted in part by the Grumman Aircraft Engineering Corporation under Contract NAS8-5415 with the George C. Marshall Space Flight Center.

TABLE 1. Average coefficient of friction between rotating metal disk and mineral powder.

Material	ATM <sup>a</sup>		$10^{-10}$ torr	
	$\mu_i$	$\mu_c$	$\mu_i$	$\mu_c$
Aluminum 7075				
on				
<u>Quartz</u>				
Fine	.27	.26	.45	.31
Coarse	.29	.26	.61	.28
<u>Basalt</u>				
Fine	.26	.19	.44	.24
Coarse	.34	.24	.80	.24
-----				
Steel 1020				
on				
<u>Quartz</u>				
Fine	.20	.17	.33	.33
Coarse	.30	.22	.43	.27
<u>Basalt</u>				
Fine	.23	.18	.33	.27
Coarse	.27	.20	.49	.26

<sup>a</sup>  $\mu_i$  = initial value of coefficient of friction;  $\mu_c$  = dynamic value of coefficient of friction.



RETURN CURRENT DISTRIBUTIONS FOR IMPROVED STABILIZATION  
OF PINCHED PLASMAS IN CURVED TUBES

T. G. Roberts and T. A. Barr, Jr.  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

INTRODUCTION

Recently a series of experiments was performed (2,3,4,6) in which a relativistic electron beam was injected along the axis of a cylindrical plasma column in a linear pinch discharge. The electron beam, with an energy of 3.5 to 5 Mev and an initial radius estimated to be on the order of 2 cm, was injected in a 30-nsec, 30,000-to 50,000-amp pulse. The pinch discharge, with a radius of 1 to 3 cm at the time of injection, had a current of the order of 30,000 to 50,000 amp which did not vary significantly during the beam transit time. Both the beam current and the discharge current were in the same direction. The pinch discharge was in argon, and the target for the pulse of high energy electrons was mounted in one of the electrodes of the linear pinch apparatus.

In other experiments (5) to check the effectiveness of the magnetic field of the linear pinched plasma for guiding the relativistic electron beam, a pinched plasma column in a coaxial tube which contained a  $90^\circ$  turn on a 6-in. radius was developed. However, performance of these experiments made it necessary to produce a curved plasma column which was at least as stable as the straight plasma columns during the time of passage of the beam. For future work it was required that the curved plasma column remain stable after the passage of the beam. This is necessary if the curved plasma column is ever to be closed on itself in an effort to trap the high energy electron beam in a closed path. Thus, the transport of the relativistic electron beam around the curve must not cause a perturbation which drives the plasma column unstable.

A simple method for producing such a curved, stable plasma column was devised by arranging the current distribution in the return conductors so that the pinched discharge is partially back-strapped only on the curved portion of the tube. It is the purpose of this report to show experimentally the effects which can be achieved by tailoring the return current distribution, and to present the results of calculations of the magnetic field in the curved portion of the pinch tube for these current distributions.

EXPERIMENTAL

The experimental apparatus has been described in previous reports, and therefore only a brief description of the linear pinch machine will be given here. The main components of the pinched discharge are a coaxial pinch tube, vacuum system, parallel plate transmission line, power supplies, associated electrical circuitry, and diagnostic equipment. The coaxial pinch tube is made of 4-in. inside diameter Pyrex glass which contained a  $90^\circ$  turn on a 6-in. radius. The return conductor was made of eight copper wires made from the outer shields of an RG8 coax. These return conductors were fitted closely to the outside of the glass tube

## Improved Stabilization of Pinched Plasmas

and were equally spaced on the straight portions of the tube. The power supplies and associated electrical circuitry consisted of the coaxial pinch tube, two triggered three-element spark gap switches, a parallel plate transmission line, two power supplies, two capacitor banks, and voltmeters for monitoring the voltage on the capacitor banks. Typical operating conditions for the pinched discharge are shown in Table 1.

TABLE 1. Typical operating conditions for linear pinch apparatus.

Condition	Measurement
Preionization bank voltage	8 to 12 kV
Preionization bank capacitance	10 $\mu$ f
Main bank voltage	4 to 20 kV
Main bank capacitance	20 $\mu$ f
Gas	Argon
Pressure	60 to 500 $\mu$ Hg
Arc length	9 to 72 in.

Effects produced by varying the return current distribution on the curved portion of the discharge are illustrated by the use of time-integrated and time-resolved photography. The coordinate system in Figure 1 shows how the return current distribution was controlled, and this coordinate system was also used in the calculations of the magnetic field within the curved portion of the pinch tube. It was assumed that the magnetic field in the  $90^\circ$  turns was the same as that which would be produced in a torus of the same radius. The center of the coordinate system was taken at the center of curvature of the tube;  $\rho$  and  $Z$  were coordinates which located a point in the plane  $\theta = \text{constant}$ . It may be noted that the current distribution consisted of nine current elements, eight of which were carried by wires located about the outside of the pinch tube, and the other was carried by the plasma column which was located within the pinch tube. The return current distribution was varied by removing one or more of these wires or by varying the location of the wires. In either case the position of the plasma column which was determined from the photographs could be made to move to any part of the wall of the pinch tube. For example, when the return conductors were placed symmetrically about the curved portion of the pinch tube, it was found that the discharge pinched, but then quickly broke up in the curved portion of the tube by moving toward the outside wall. When the return conductors were twisted around the curved portion of the pinch tube, the discharge behaved in a similar manner. However, if the return conductors were not twisted but were placed coaxial with the pinch tube and correctly spaced around the circumference of the tube, this effect could be avoided, and fairly stable pinched plasma columns could be obtained in curved tubes. The best spacing of the return conductors for the curved tubes used in these experiments was to have five of the eight return conductors fairly close together on the outside of the curve

on the major radius and one on the inside of the curve on the major radius. The other two return conductors were placed between these conductors on the major radius but closer to the one on the inside of the major radius (Fig. 2). This distribution was used in most of the calculations to be described later.

A time-integrated photograph of the behavior of the plasma column when the return conductors are equally spaced about the pinch tube is shown in Figure 3. This is the current distribution which worked best on the straight portion of the discharge. Here it may be seen that the plasma pinched and then moved toward the outside wall as would be expected. Figure 4 is a time-integrated photograph of the plasma behavior when the return conductors were spaced about the pinch tube so that the discharge was partially back-strapped at the outside of the pinch tube. Here, it may be seen that the pinch formed near the axis of the tube and was as stable as the pinch in the straight portion of the discharge. Figure 5 shows three photographs of the various shapes into which the discharge may be twisted with the last photograph showing the plasma column which was used as a guide for the high energy electron beams.

Streak camera photographs of 10- $\mu$ sec duration which illustrate the dynamic behavior of the plasma both in the straight and curved portions of the same discharge are shown in Figure 6. The photo on the left is of the straight portion where the return conductors were placed symmetrically about the tube, and that on the right was taken in the curved portion where the discharge was partially back-strapped by use of the "best" distribution. It may be seen that the discharge could be made to behave quite similarly in both parts of the pinch tube. Figure 7 shows a series of 10- $\mu$ sec duration streak camera photographs which were selected to illustrate how the plasma column may be moved about in the pinch tube by varying the return current distribution. There are two streak camera photographs for each current distribution. Each photo is of the curved portion of the discharge tube. One photo of each set of two was taken looking perpendicular to the plane containing the axis of the tube and the other was taken  $90^\circ$  from this direction, i.e., the camera was placed at  $\theta = 90^\circ$  and at  $\theta = 0^\circ$ . For these photos the return current distribution was varied by disconnecting one or more of the return conductors from the distribution which was used to obtain the photograph in Figure 4.

#### B FIELD CALCULATIONS

The coordinate system used for the calculations of the magnetic field in the curved portion of the discharge tube is shown in Figure 1. The current distribution was specified by giving the coordinates of the eight return conductors and the current carrying plasma column. It was assumed in most of the calculations that the total current was uniformly distributed over the conducting areas and that each return conductor carried one unit of current or  $1/8$  of the total current while the plasma column carried eight units of current in the opposite direction. For the "best" distribution of the return conductors, calculations were made for three positions of the plasma column; the position as determined from the streak camera photographs of Figure 6 and positions half the diameter of the plasma column on either side of this position. Calculations were

# Improved Stabilization of Pinched Plasmas

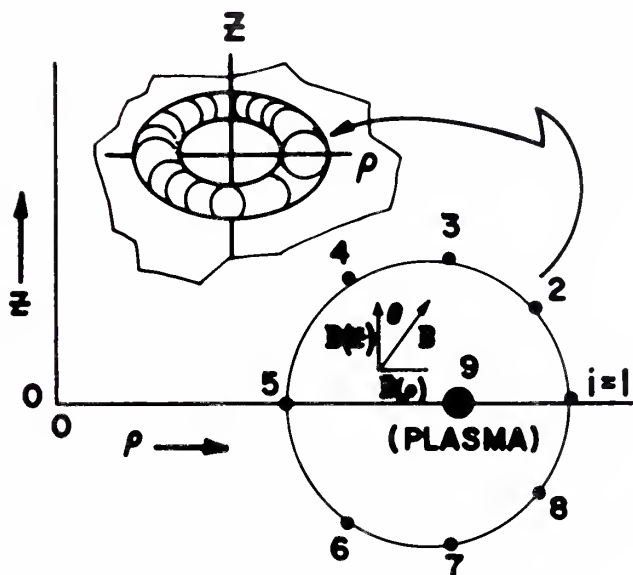


FIGURE 1. Coordinate system for calculating B fields in curved tubes.

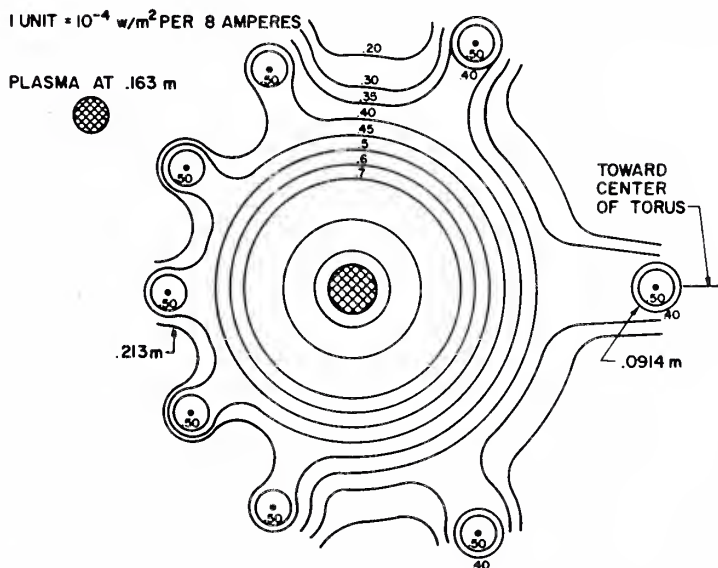


FIGURE 2. B field contours for the case of best stability.

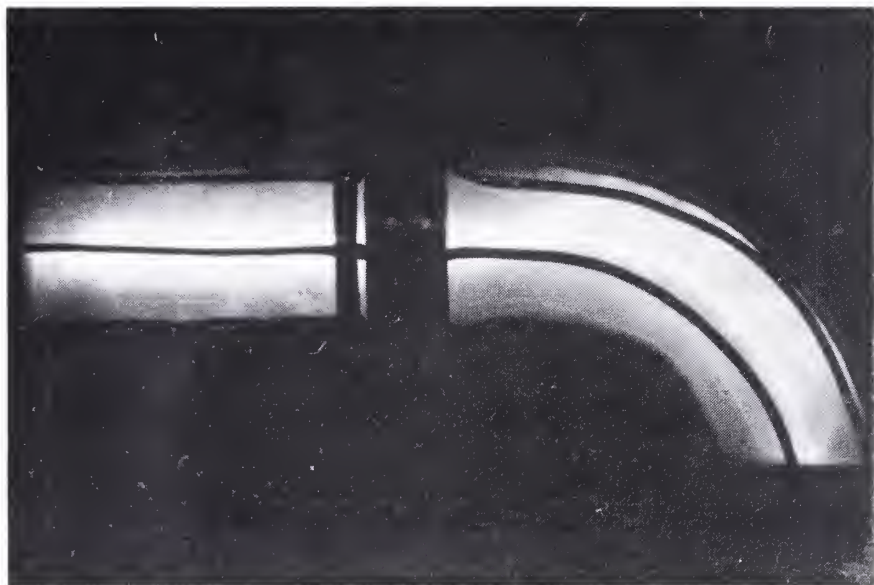


FIGURE 3. Time-integrated photograph of curved plasma column with uniformly spaced return conductors.



FIGURE 4. Time-integrated photograph of curved plasma column with returned conductors spaced so that discharge is partially back-strapped.



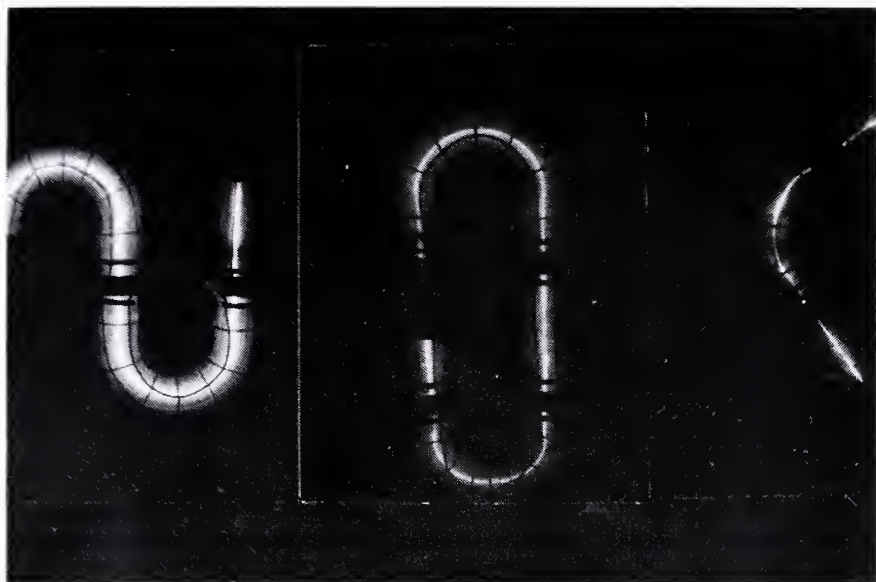


FIGURE 5. Time-integrated photographs of plasma columns which have been formed into different shapes by the method of partial back-strapping.



FIGURE 6. Streak photographs of the development of the plasma column in a straight tube (left) and in a curved tube (right) where the discharge has been partially back-strapped.



also made where it was assumed that the return conductors carried unequal parts of the total current and where the return conductors were spaced equally about the curved portion of the discharge tube.

The contribution to the field from any one of the conductors is given by (1):

$$B_z = A(I_1 - a^{-1}\rho I_2) ;$$

$$B_\rho = Aa^{-1}zI_2 ,$$

where the conductor is located at  $\rho = a$ , and

$$I_1 = \pi^{-1} \int_0^\pi (1 - b \cos \theta)^{-3/2} d\theta ,$$

$$I_2 = \pi^{-1} \int_0^\pi (1 - b \cos \theta)^{-3/2} \cos \theta d\theta ,$$

$$A = \frac{1}{2} \mu I a^2 (a^2 + z^2 + \rho^2)^{-3/2} ,$$

and

$$b = 2a\rho(a^2 + z^2 + \rho^2)^{-1} .$$

The space in the discharge tube and near the return conductors was divided into a coordinate mesh, and then a computer was used to calculate the contribution to the field from each conductor at the center of each coordinate mesh. The field intensity was then obtained by adding each of these contributions. Constant intensity lines were then plotted to obtain the final field configuration for each current distribution used. Figure 8 shows the magnitude of the magnetic field as a function of the radius of the discharge tube for the case of "best" return current distribution and the experimentally determined position of the plasma column. The field contours within the pinch tube for this case are shown in Figure 2.

Other calculations indicated that for the "best" distribution of the return conductors, the field was changed more by a slight movement of the position of the plasma column than by removing the assumption that each conductor carried an equal part of the total current. The fields obtained when the return conductors were equally spaced were such to indicate that the plasma should move to the outside wall.

## DISCUSSION

It has been shown experimentally that the stability of pinched discharges in curved tubes can be improved by the simple method of arranging the return conductors so that the discharge is partially back-strapped in the proper manner. The magnetic field in the curved portion of the discharge tube used in the experiments has been calculated, and the field contours obtained are consistent with an equilibrium configuration. However, it should be noted that the pinch used in these experiments was not

# Improved Stabilization of Pinched Plasmas

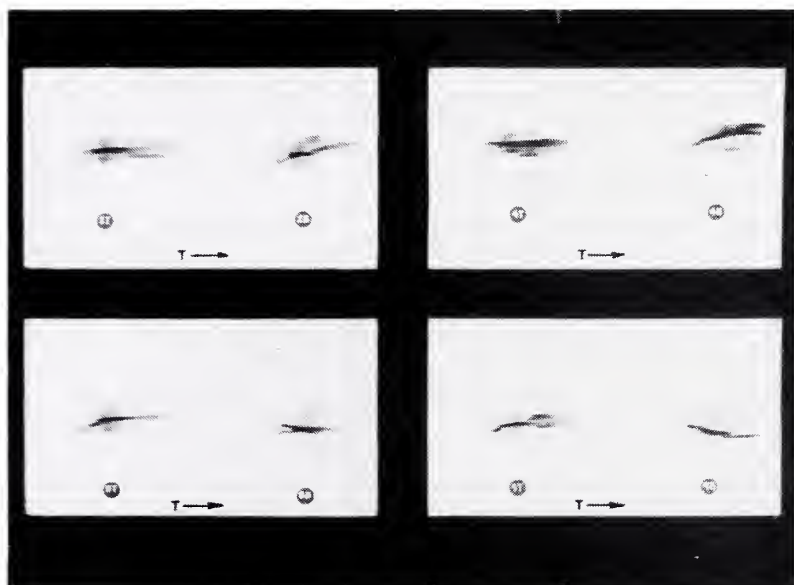


FIGURE 7. Streak photographs showing how the plasma column can be manipulated by tailoring the return current distribution.

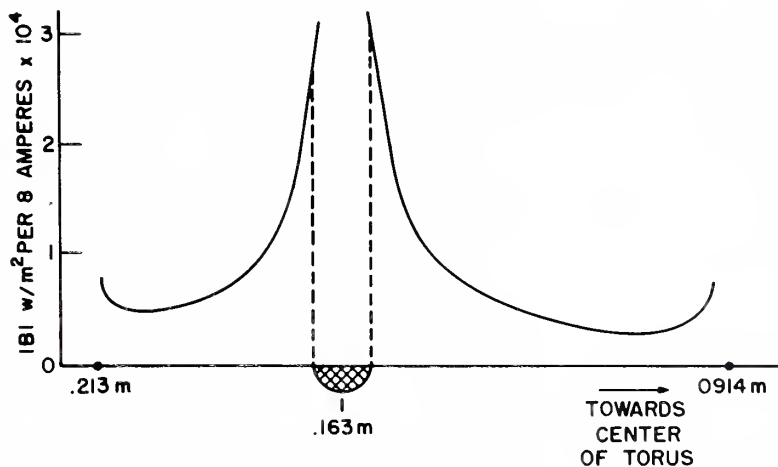


FIGURE 8.  $|B|$  versus  $\rho$  for the current carrying plasma located at  $\rho = 0.163$  m, the position of best stability.

driven very hard, and the positions of the return conductors for other pinch machines may be slightly different from those determined here. It would be best to determine experimentally the proper spacing of the return conductors for each pinch machine and each curved used.

LITERATURE CITED

1. Bartberger, C. C. 1950. The magnetic field of a plane circular loop. J. Appl. Phys. 21:1108. \*
2. Roberts, T. G. 1965. The experimental verification of self-focusing in intense, relativistic, electron beams. U. S. Army Missile Command Report No. RR-TR-65-17.
3. Roberts, T. G. 1966. Experimental studies of the Bennett pinch. U. S. Army Missile Command Report No. RR-TR-66-16.
4. Roberts, T. G. 1967. Guiding of self-focused relativistic electron beams. U. S. Army Missile Command Report No. RR-TR-67-16.
5. Roberts, T. G., and W. H. Bennett. 1966. Experimental studies of the relativistic pinch. Science 1966:13.
6. Roberts, T. G. and W. H. Bennett. 1968. The pinch effect in pulsed streams at relativistic energies. J. Plasma Phys. 10:381-389.

## $N_2-CO_2$ Lasers

### $N_2-CO_2$ LASERS

G. J. Hutcheson and T. G. Roberts  
U. S. Army Missile Command  
Redstone Arsenal, Alabama

#### INTRODUCTION

Even though it has been less than five years since the advent of the  $CO_2$  laser (17) a reasonably good understanding of the field of molecular lasers has become known. This knowledge shows that another molecular laser will probably not be developed which will surpass the  $CO_2$  laser in terms of output power, efficiency, and ease of construction and operation. The dramatic development of this laser is illustrated by the increase in output power from a watt or so to the 8.8 kilowatt level and by the increase in efficiency from a percent or so to the 30% level.

Laser action on the vibrational-rotational transitions of pure  $CO_2$  was first reported by Patel (17). In another paper he (18) reported that  $CO_2$  molecules could be selectively excited through resonant transfer of vibrational energy with  $N_2$  molecules. This was the first time a two-component gas optical laser was reported where the upper laser level was excited by the resonant transfer of vibrational energy. Shortly after this Moeller and Rigden (15) reported that the addition of He to the  $N_2-CO_2$  mixture could considerably increase the output power and efficiencies of the laser. Subsequently, several laboratories (21,24,28) began construction of very high power  $CO_2$  lasers. This work culminated with the 8.8-kilowatt device of Raytheon (13) which is made of 15 lengths, each 50 ft long, arranged on four levels, and connected optically to form a continuous 750-ft device. The history of this development is illustrated in Figure 1. Even though the  $CO_2$  laser may be operated in other forms, this curve includes dates only for the electrically excited or glow discharge type of lasers, which is the only type considered in this paper. The curve should not be used for extrapolation, since more powerful lasers of this type are not presently under development.

The glow discharge  $CO_2$  molecular laser (23) generally consists of a water-cooled glass tube which contains a gas mixture of  $CO_2$ ,  $N_2$ , and He at a total pressure of a few torr, the partial pressures being about 0.5, 1, and 4.5 torr, respectively. The tube is located between two mirrors, one of which has some means, such as a partially transmitting mirror or a hole, for coupling out part of the photon flux in the cavity, and the gas mixture is subjected to an electric discharge -- either ac, dc, RF, or pulsed (11,26). The nature of the excitation, produced by collisions of the molecules with the energetic electrons provided by the discharge and with themselves, is such that a highly nonequilibrium steady state which may contain population inversions can be obtained.

Applications of the electrically excited  $CO_2$  laser have, in a sense, kept up with the rapid increase in output powers. These applications have ranged from metal cutting (27) and hemostatic surgery (16) to infrared radar (14) and the extermination of water hyacinth (5). Even though these applications are very interesting, they will not be discussed here; instead, we will review the theory of operation of the glow discharge type

of CO<sub>2</sub> molecular laser with emphasis upon the mechanisms which lead to the production of high powers and high efficiencies.

### THEORY

In atomic systems (8) spectra are produced by transitions between different electronic states. These transitions involve states with large energy differences, and the spectra lines generally appear in the visible or the ultraviolet. However, in molecular systems (10) not only electronic transitions occur, but also transitions between various vibrational and rotational substates of a given electronic state. In CO<sub>2</sub>, for instance, infrared radiation is produced by transitions between vibrational substates of each electronic state, while transitions between rotational levels produce radiation in the microwave region. In general the lifetimes of atomic states are determined by their radiative decay rates, whereas the lifetimes of the molecular vibrational and rotational states are collision-dominated with the lifetimes of the rotational states being very short as compared to those of the vibrational states.

In CO<sub>2</sub>, laser action takes place between vibrational-rotational levels of the electronic ground state. A linear symmetric triatomic molecule like CO<sub>2</sub> (9) has three normal modes of vibration: a symmetric stretch mode along the axis of the molecule, an asymmetric stretch mode also along the axis, and a twofold degenerate bending mode transverse to the axis. In the first approximation each of these modes can be considered as an independent harmonic oscillator so that three quantum numbers are used to characterize the vibrational levels. Actually, four numbers are needed since the bending mode is degenerate. These quantum numbers are usually written  $\nu_1, \nu_2^{\ell}, \nu_3$  where  $\nu_1$  represents the number of excitations of each of the three normal modes;  $\nu_1$ , the symmetric stretch;  $\nu_2$ , the bending mode; and  $\nu_3$ , the asymmetric stretch. The superscript ( $\ell$ ) indicates the degeneracy of the bending mode. Each of these vibration levels is split into a series of rotational sublevels characterized by the angular momentum quantum number ( $J$ ). For symmetry reasons, the selection rules show that odd or even  $J$  values can be missing from certain vibrational levels. Figure 2 is an energy level diagram for CO<sub>2</sub> which illustrates most of the above points.

To produce CW laser action in any medium, we must have a mechanism for inverting the populations, an upper level with a lifetime longer than that of the lower level, and a resonator in which the gain is greater than the loss. The CO<sub>2</sub> laser has the energy level arrangement of a standard four-level laser. The 00<sup>0</sup>1 vibrational level is the upper laser level, the 10<sup>0</sup>0 and 02<sup>0</sup>0 vibrations are the lower laser levels, and the 01<sup>1</sup>0 is the level above the ground state through which the lower levels depopulate. The inversion is produced by collisions with electrons and other molecules and the lifetimes of the vibrational and rotational levels are determined by collisions.

In discharges of the type found in CO<sub>2</sub> lasers and in other steady-state plasma devices (22) such as plasma jets, thermal equilibrium is not established, and therefore there is no such thing as the temperature. However, in the glow discharge various degrees of freedom of the CO<sub>2</sub> system are so strongly coupled that each may be characterized by a Boltzmann distribution and a temperature. More than one temperature, however, is needed

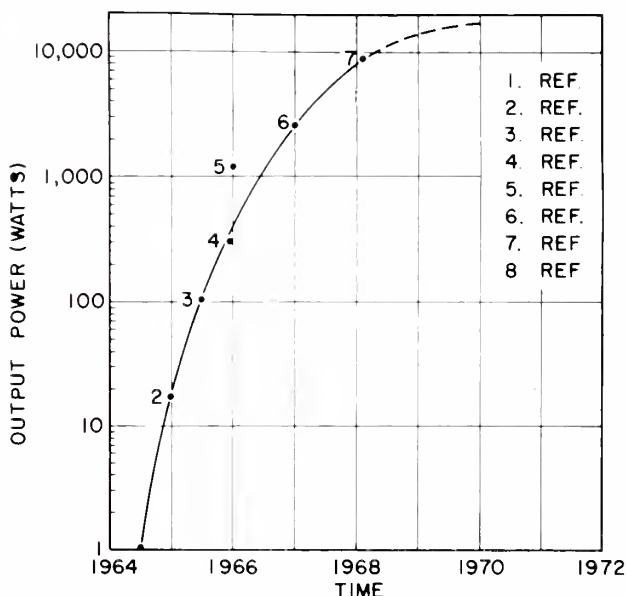


FIGURE 1.

to describe the entire system. The rotational levels are strongly coupled through collisions to the translational energy distribution of the molecules and thus tend to thermalize; that is,  $T_r \rightarrow T_{\text{gas}}$ . While the vibrational levels are more closely coupled to the electron energy distribution in the discharge, it follows that the vibrational temperature tends to approach that of the electrons  $T_r \rightarrow T_e$ . Since the electron temperature can be much greater than the gas temperature, the vibrational temperature can also be much greater than the rotational temperature. Under these conditions the population within each set of rotational sub-levels is given by a Boltzmann distribution

$$N_J \approx g_J e^{-\left(\frac{E_o(J)}{k T_r}\right)}.$$

However, the total number of particles distributed among these  $J$  states is determined by  $T_v$ . Thus the inversion requirement takes the form (20)

$$\frac{N_v 'J'}{g_J'} > \frac{N_v ''J''}{g_J''},$$



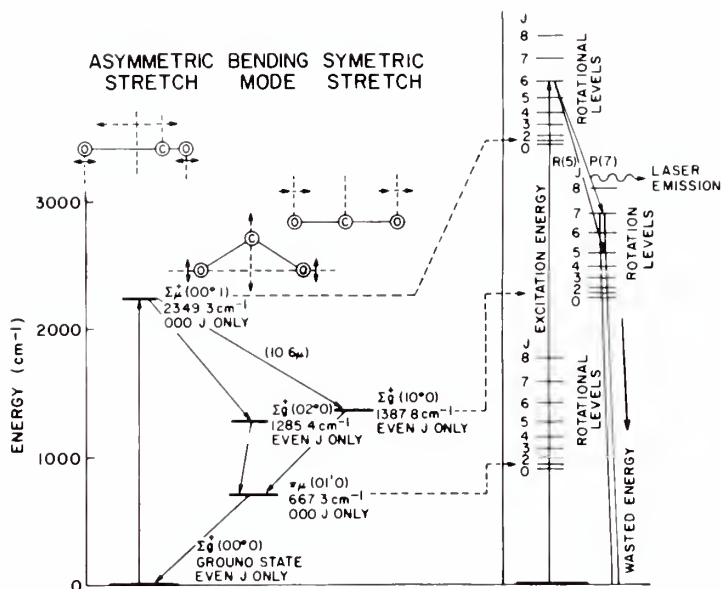


FIGURE 2.

and it is not necessary that an inversion of the vibrational levels actually exist for laser action in the P branch. That is,  $N_v''$  could be greater than  $N_v'$  and the above equation could still hold. When this happens, a partial inversion is said to exist, and Polanyi (20) has shown that P branch laser action can be obtained if the rotational temperature is sufficiently less than the vibrational temperature,

$$\frac{T_r}{T_v} > \frac{E_o(J') - E_o(J'')}{E_o(V'') - E_o(V')} .$$

The gain in the medium depends on this inversion, and to produce amplification of the stimulated emission, the change in intensity of the resonant radiation per unit length of the cavity must be greater than zero:

$$\left(\frac{dI}{dx}\right)_{\text{gain}} + \left(\frac{dI}{dx}\right)_{\text{loss}} > 0.$$

This requirement can be written as

$$\alpha - \beta > 0,$$

where  $\alpha$  is the gain coefficient for the transition considered and  $\beta$  is a

generalized loss coefficient. For the case where  $T_r = T_{gas} = T$  the gain coefficients for P and R branch transitions between the  $(00^01)$  and  $(10^00)$  vibrational levels at the peak of the gain curve in the Doppler broadened limit can be written as (6):

$$\alpha_P(J) = A J \left\{ R \exp \left[ -F_1(J-1) \frac{hC}{kT} \right] - \exp \left[ -F_2(J) \frac{hC}{kT} \right] \right\}$$

$$\alpha_R(J) = A (J+1) \left\{ R \exp \left[ -F_1(J-1) \frac{hC}{kT} \right] - \exp \left[ -F_2(J) \frac{hC}{kT} \right] \right\}$$

where the new symbols are defined by:

$N_1, N_2$  = total population densities of the  $(00^01)$  and  $(10^00)$  levels

$R = (N_1/N_2) (B_1/B_2)$  essentially the inversion ratio

$$F_1(J) = B_1 J(J+1)$$

$$F_2(J) = B_2 J(J+1)$$

$$\left. \begin{aligned} B_1 &= 0.3866 \text{ cm}^{-1} \\ B_2 &= 0.3897 \text{ cm}^{-1} \end{aligned} \right\} \text{ rotational constants}$$

$k_{12}(J) = S_{12P}$  the line strength of P-branch transitions

$k_{12}(J+1) = S_{12R}$  the line strength of the R-branch transitions

$k_{12}$  = that part of the matrix element which is independent of J

$$A = \frac{8\pi^3}{3k} \sqrt{\frac{MC^2}{2\pi k}} T^{-3/2} k_{12} N_2 B_2$$

and  $k$  is the Boltzmann constant.

Djeu *et al.* (6) have measured the gain  $\alpha$  as a function of the quantum number  $J$  for the first 23 transitions in both the P and R branches. From a fit of the data to the above formulas, they obtained values for  $A$ ,  $R$ , and  $T$  in an active  $N_2-CO_2$ -He medium typical of the type considered in this review. Using these values and the measured value of the spontaneous transition probability, they were able to determine absolute numbers for the populations in the upper and lower vibrational states. Their results were:

$$A = 0.076 \text{ m}^{-1}; \quad T = 340^\circ K$$

$$R = 2.25; \quad \frac{N_{00^01}}{N_{10^00}} = 2.27$$

$$N_{00^01} = 3.27 \times 10^{15} \text{ cm}^{-3}; \quad N_{10^00} = 1.44 \times 10^{15} \text{ cm}^{-3}.$$

Thus, a total inversion exists in these systems with more than 17% of the  $\text{CO}_2$  molecules being in the upper laser level and about 8% being in the lower laser level.

In an  $\text{N}_2\text{-CO}_2\text{-He}$  system both the  $\text{N}_2$  and the He contribute either directly or indirectly to the above inversion ratio. Laser output may be produced in pure  $\text{CO}_2$  (3) at very low output powers by the interaction of the vibrational states with the electron distribution, but the addition of the proper amounts of  $\text{N}_2$  or He can increase the laser power many times (15,18). The  $\text{N}_2$  has a metastable vibration level,  $v = 1$ , which differs from the  $00^0_1$  level of  $\text{CO}_2$  by approximately  $18\text{ cm}^{-1}$ ; but, since the thermal energy at room temperature is  $210\text{ cm}^{-1}$ , the  $00^0_v$  levels of  $\text{CO}_2$  are selectively excited by the  $v_n$  levels of  $\text{N}_2$  by resonant transfer collisions. This process strongly couples these vibration states of  $\text{CO}_2$  and  $\text{N}_2$ ; therefore, their respective vibrational temperatures approach each other. The electron excitation cross sections for  $\text{N}_2$ 's are larger than those for  $\text{CO}_2$ . Thus, the  $\text{N}_2$  vibrational temperature more closely approaches the electron temperature, and by the resonant interaction with  $\text{N}_2$ , the vibrational temperature and population of the  $\text{CO}_2$  upper laser level is raised and greater laser output power is produced.

The mechanisms through which the He works have been discussed by Horrigan (12) as follows:

1. Because of helium's high thermal conductivity and its good thermal contact with the  $\text{CO}_2$  rotational levels, it cools the rotational levels and shifts the peak gain to lower P branch transitions. The helium conducts heat rapidly to the walls, thus making both the gas temperature and the rotational temperature much lower than that without helium. This tends to increase the differences between  $T_v$  and  $T_r$  further.

2. When the steady-state populations of the rotational levels are disturbed by laser action, the helium tends to rethermalize them very quickly. This rethermalization reduces input to other levels and supplies more input to the lasing levels. This means that nearly all the rotational levels of the upper level contribute to laser action either directly or indirectly by rapidly refilling those rotational levels which exhibit highest gain.

3. Helium also greatly reduces the lifetimes of the lower laser level which are collision-dominated; this causes a greater population inversion and increases the gain.

Many substances other than He have been added to the  $\text{N}_2\text{-CO}_2$  mixture in hope of finding mechanisms to increase the population inversion in  $\text{CO}_2$ , either by additional pumping or by aiding in emptying the lower laser level. The effects (25) of some of these additives are illustrated in Figure 3, where it may be seen that a little nitrous oxide can stop the laser action, but the addition of deuterium has qualitatively the same effect as that of helium.

The effects of the additives illustrated in Figure 3 are for systems where the gas mixture is flowed through the laser cavity. However, static  $\text{CO}_2$  lasers have also received considerable attention, and in these systems

# $N_2-CO_2$ Lasers

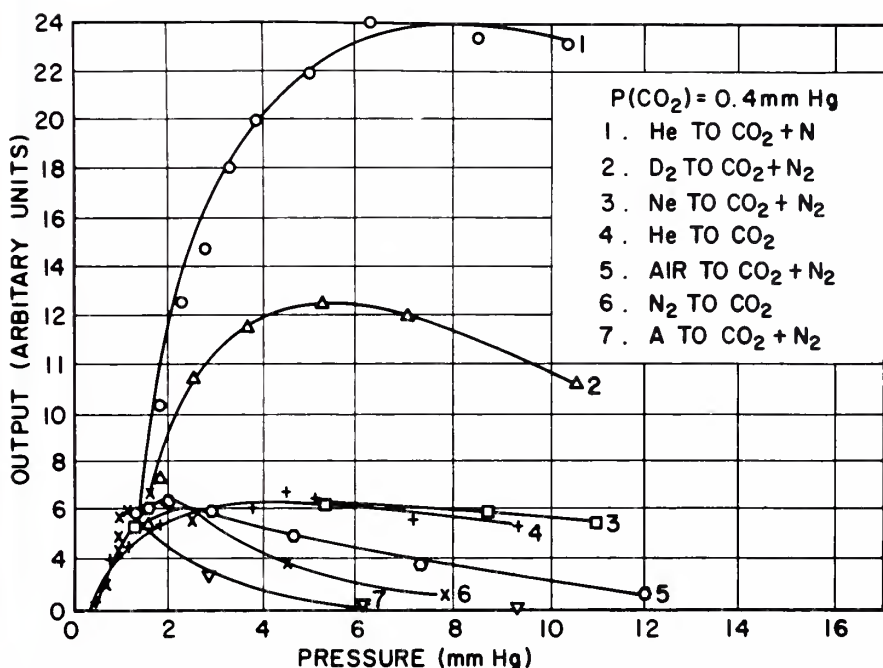


FIGURE 3.

the effects of the additives can be different. For example, Witteman (30) has reported constructing a static CO<sub>2</sub> laser with a lifetime of 3000 hr which produces output powers per unit length near those obtained with similar flowing systems. But Whitehouse (28) has shown that it is quite difficult to duplicate Witteman's results and that the basic mechanisms involved in static systems are not well understood. For example, the output and lifetime of a static system depend not only on the gas composition, thermal effects, and electrical characteristics of the discharge, but because of the accumulative electrochemical processes in the active medium, there is also a dependence on the electrode and cavity materials. Witteman used porous fused quartz charged with oxygen for the laser tube. This makes extra oxygen available for recombining with discharge-produced CO to form CO<sub>2</sub>. The quartz, though, is not necessary since Clark and Wada (4) have found that long lifetimes can be obtained with Pyrex tubing when the gas mixture is CO<sub>2</sub>-Xe-He.

The CO<sub>2</sub> laser is useful for Q-switching techniques (7,19) because of the long lifetimes of its upper laser levels. If the laser cavity is misaligned by rotating one of the mirrors out of position while the medium is continuously pumped, a large steady-state population inversion like that mentioned above is produced. Then when the cavity is suddenly aligned, a Q-switch pulse of high peak power is produced which causes a rapid depletion of the populations of the upper laser levels. Therefore,

when the Q-switching rate is such that the interval between pulses is longer than the lifetimes of the levels, the energy in each pulse will be independent of the rate of Q-switching. But, when the Q-switching rate is such that the interval between pulses is comparable to the lifetimes of the laser levels, the energy in each pulse begins to fall off. Also, at low gas pressures, the rate of Q-switching can be made fast enough so that the interval between pulses is short enough to decouple the rotational levels; and the various transitions can oscillate independently. Otherwise, the situation is similar to the CW case where only a few lines oscillate.

#### DISCUSSION

More powerful CO<sub>2</sub> laser devices of the type discussed in this paper will probably not be constructed. Higher powers will probably come from technological developments resulting from the attempts to get power out of shorter devices which either work at higher pressures, at high flow rates, or with some form of excitation other than electrical (4,29). Even though another molecular discharge laser will probably not be developed which will surpass the CO<sub>2</sub> laser in terms of output power, efficiency, and ease of construction and operation, molecular lasers such as the new chemical laser (1,22) have the potential to surpass the CO<sub>2</sub> lasers in output power.

#### LITERATURE CITED

1. Airey, J. R. 1969. Investigation of pulsed chemical lasers. AVCO Corporation, Everett, Mass.
2. Basov, N. G., A. N. Oraevskii and V. A. Shcheglov. 1967. Sov. Phys.-Tech. Phys. 12:243.
3. Clark, P. O. and M. R. Smith. 1966. Pulsed operation of CO<sub>2</sub>-N<sub>2</sub>-He lasers. Appl. Phys. Letters 9:10.
4. Clark, P. O. and J. Y. Wada. 1968. Characteristics of CO<sub>2</sub>-Xe-He lasers. Hughes Research Laboratories, Malibu, California, Private Communication.
5. Couch, R., J. Ehrlich, and T. A. Barr. 1969. Effects of N<sub>2</sub>-CO<sub>2</sub>-He laser energy on water hyacinths. J. Ala. Acad. Sci. 40:132.
6. Djeu, N., T. Kan, and G. Wolga. 1968. Gain distribution, population densities, and rotational temperature for the (00<sup>0</sup>1)-(10<sup>0</sup>0) rotation-vibration transitions in a flowing CO<sub>2</sub>-N<sub>2</sub>-He laser. IEEE J. Quant. Electron. QE-4:5.
7. Flynn, G. W., L. O. Hocker, A. Javan, M. A. Kovas and C. K. Rhodes. 1966. Progress and applications of Q-switching techniques using molecular gas lasers. IEEE J. Quant. Electron. QE-2:9.
8. Herzberg, G. 1940. Atomic spectra. D. Van Nostrand Company, Inc., Princeton, N. J.

## $N_2-CO_2$ Lasers

9. Herzberg, G. 1950. Spectra of diatomic molecules. D. Van Nostrand Company, Inc., Princeton, N. J.
10. Herzberg, G. 1960. Molecular spectra and molecular structure. Vol. I, II. D. Van Nostrand Company, Inc., Princeton, N. J.
11. Hill, A. E. 1968. Multijoule pulses from  $CO_2$  lasers. Appl. Phys. Letters 12:9.
12. Horrigan, F. 1966. High power gas laser research. Final Technical Report, Raytheon Company Research Division.
13. Horrigan, F. A., C. A. Klein, R. I. Rudko, and D. T. Wilson. 1968. High power gas laser research. Final Technical Report, Raytheon Company Research Division.
14. Miles, P. A. and J. W. Lotus. 1968. A high-power  $CO_2$  laser radar transmitter. IEEE J. Quantum Electron. Vol. QE-4.
15. Moeller, G. and J. D. Rigden. 1965. High-power laser action in  $CO_2$ -He mixtures. Appl. Phys. Letters 7.
16. Mullins, F., W. B. Jennings, and L. N. McClusky. 1968. Liver-resection with the continuous wave carbon dioxide laser from experimental observation. American Surgeon 34:10, October.
17. Patel, C. K. N. 1964. Interpretation of  $CO_2$  optical maser experiments. Phys. Rev. Letters 12:21.
18. Patel, C. K. N. 1964. Selective excitation through vibrational energy transfer and optical maser action in  $N_2-CO_2$ . Phys. Rev. Letters 13:21.
19. Polant, R. M. and T. H. Lloyd. 1967. Design, construction, and study of a Q-switched  $CO_2$ - $N_2$ -He gas laser. Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.
20. Polanyi, J. C. 1965. Vibrational-rotation population inversion. Applied Optics Supplement on Chemical Lasers.
21. Rigden, J. D. and G. Moeller. 1966. Recent developments in  $CO_2$  lasers. IEEE J. Quant. Electron. QE-2:9.
22. Roberts, T. G. 1962. The significance of spectroscopically determined plasma jet temperatures. Army Science Conference, Vol. 11.
23. Roberts, T. G., J. J. Ehrlich, and G. J. Hutcheson. 1967. The construction and performance of a high power C. W. gas laser. Ala. Acad. Sci. 38:71.
24. Roberts, T. G., G. J. Hutcheson, J. J. Ehrlich, and W. L. Hales. 1967. Experimental development of  $N_2-CO_2$  lasers. USAMICOM Report No. RR-TR-67-11.



25. Roberts, T. G., J. J. Ehrlich, W. L. Hales, and T. A. Barr, Jr. 1967. IEEE J. Quant. Electron. QE-3:11.
26. Sawyer, J. M. and L. E. S. Mathias. 1966. Performance of a pulsed carbon dioxide laser. Services Electronics Research Laboratory, Baldock, England, Technical Report No. M241.
27. Sullivan, A. B. J. and P. T. Houldcroft. 1967. Gas-jet laser cutting. British Welding Journal: August.
28. Whitehouse, D. R. 1967. High power gas laser research. Final Technical Report, Raytheon Company Research Division.
29. Wisniewski, E. E., M. E. Fein, J. T. Verdeyen, and B. E. Cherrington. 1968. Thermal production of a population inversion in carbon dioxide. Appl. Phys. Letters 12:8.
30. Witteman, W. J. 1966. Inversion mechanism, population densities and coupling-out of a high-power molecular laser. Phillips Research Reports, Vol. 21, No. 2.

## Toxicity Profile in Valley Creek

### THE USE OF MASONITE PLATE SAMPLERS IN DETERMINING TOXICITY PROFILE IN VALLEY CREEK, JEFFERSON COUNTY, ALABAMA

Walter M. Tatum  
Alabama Department of Conservation  
Montgomery, Alabama

#### INTRODUCTION

The headwaters of Valley Creek are located in the northwestern portion of Jefferson County and originate within the corporate limits of Birmingham. The creek measures approximately 45 miles from its headwater to its confluence with the Black Warrior River. A maximum flow of 23,000 cfs was recorded on February 11, 1961, and a minimum flow of 59 cfs was recorded in June and July of 1936. The average flow, based on flows during 1953 - 1958 and including the flow during 1965, was 321 cfs.

The upper reaches of Valley Creek are located in a highly industrialized portion of Jefferson County and consequently receive a large amount of polluting effluents. Waste discharges from industrial and municipal sources are located within the upper 14 miles of the creek. Studies by the Alabama Water Improvement Commission during August, 1964, indicated a flow of 12 million gal. per day in Valley Creek above all waste discharge points. The total waste discharge into Valley Creek is 64 million gal. per day, or approximately 5 times the flow during August 1964. It is also interesting that the daily waste discharge in Valley Creek is approximately 31% of the average flow in the creek measured over a seven year period.

#### MATERIALS AND METHODS

Plate samplers used in this study were constructed of 1/8 in. thick tempered hardboard (Masonite) as described previously (1,2). Each sampler consisted of two 3-in. square plates separated by a 1-in. square plate. A small hole was bored through the center of each plate and the 3 plates were held firmly together by a 3-in. bolt through the holes in the plates fitted with a nut and washer.

Samplers were suspended in a fertilized pond at a depth of about two feet and allowed to remain for approximately one month. Generally, this was sufficient for accumulation of a dense population of larval chironomids on the samplers. Samplers were placed in water-filled plastic bags and transported to sampling stations along Valley Creek. The stations used were located above and below all known sources of pollution, and in an unpolluted tributary stream to Valley Creek and above the mouth of Valley Creek on the Warrior River (Fig. 1). Three samplers were set out at each sampling station during each of the two sampling periods. Samplers were allowed to remain in the water at the station for one week after which the number of living chironomids on each sampler was determined.

#### RESULTS AND DISCUSSION

The selection of check stations was based on the assumption that

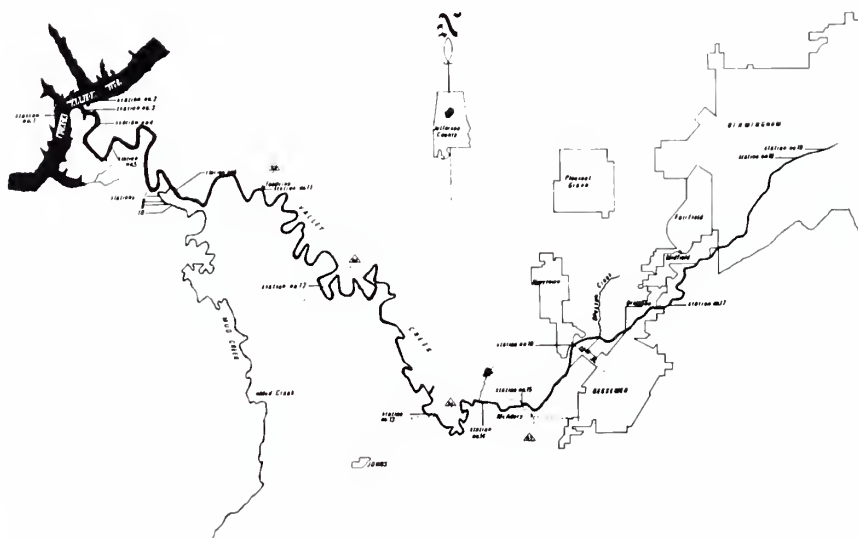


FIGURE 1. Valley Creek watershed.

ecological conditions, other than polluting effluents, were similar. Therefore, it was assumed that polluting effluents from Valley Creek would show no detrimental influence on the check stations. However, check samplers placed in Mud Creek during the 1968 sampling at 50, 200, 250 and 300 yards from its confluence with Valley Creek exhibited increased chironomid survival as the distance from Valley Creek increased (Table 1). Comparison of survival at individual stations on Mud Creek to the average from check stations showed reductions of 98.3 and 52% at 50 and 200 yd, respectively, up Mud Creek, and increases of 162 and 145% at 250 and 300 yd, respectively, up the creek (Table 2). Probably, this was a result of water of low dissolved oxygen content and/or toxic materials moving into Mud Creek from Valley Creek.

The uppermost check stations, 18 and 19, were obviously not affected by municipal or industrial effluents; however, stream characteristics at these stations were vastly different from those at the remaining stations. No flow data were available for comparison, but the width of the stream at stations 18 and 19 was approximately 1/10 that at station #17. Water temperature at stations 18 and 19 during August, 1968, was 18°F lower than historical August temperatures measured at the Oak Grove gauging station.<sup>1</sup> It is possible that chironomids on the samplers placed into

<sup>1</sup>U. S. Geological Survey, Water Resources Division, Rain data, station #02-4620.00 for period 1/31/63-7/29/68.

# Toxicity Profile in Valley Creek

TABLE 1. Number of living chironomids on masonite plate samplers following one week exposure to Valley Creek.

No.	Station Location	Avg. No. Living Chironomids	
		May 1966	August 1968
1	½ mi. below mouth of Valley Creek on Warrior River	170	22.7
2	½ mi. above mouth of Valley Creek on Warrior River (check)	27.2	48.0
3	200 yards up Valley Creek	106.6	285.5
4	1 mile up Valley Creek	92.6	439.7
5	3 miles up Valley Creek	0	284.7
6	7½ mi. up Valley Creek (just above mouth of Mud Creek)	7.0	51.0
7	50 yards up Mud Creek (check)	142.7	1.3
8	200 yards up Mud Creek (check)	40.0	37.7
9	250 yards up Mud Creek (check)	45.7	206.0
10	300 yards up Mud Creek (check)	89.7	192.3
11	Bridge on Gilmore Road 11 miles South of Warrior River	17.3	16.0
12	Bridge on Oak Grove to Hueytown Rd. 18 mi. South of Warrior River on Valley Creek	25.3	44.0
13	Bridge on John's Road	0	0
14	On John's Road ½ mi. below Hyde & Tallow Company	0	0
15	At Junction of John's Rd. & Powder Plant Rd. ¾ mi. below Sewage Treatment Plant	0	Lost
16	19th Street Bridge Crossing in Bessemer below TCI, Woodward, U.S. Pipe, & Copper's Co.	Out of Water	Lost
17	Highway 11 Bridge Crossing 11 miles above all known sources of Industrial pollution	Out of Water	Lost
18	At George Ward Park, Green Springs (headwaters of Valley Creek)	Out of Water	33.6
19	5th Street South & Green Springs Ave. Headwaters of Valley Creek (check)	Out of Water	30.3
		69.0	78.5

TABLE 2. Chironomid survival in Valley Creek.

Station	Survival; % Variation from Control	
	May 1966	August 1968
1	+146	- 71.1
* 2	- 61	- 39.0
3	+ 54	+264
4	+ 34	+459
5	-100	+263
6	- 90	- 35
* 7	+107	- 98.3
* 8	- 42	- 52.0
* 9	- 38	+162
*10	+ 29	+145
11	- 75	- 80
12	- 63	- 44
13	-100	-100
14	-100	-100
15	-100	-
16	-	-
*17	-	-
*18	-	- 57
*19	-	- 61

\*Check Stations

Valley Creek at stations 18 and 19 migrated from the samplers or were killed by the drastic temperature change.

All organisms for a distance of 10 miles below Opossum Creek on Valley Creek were killed during each of the two sampling periods (Table 1). During the 1966 sampling period, organisms were reduced by 63, 75, 90, and 100% at 18, 11, 7½, and 3 miles, respectively, up Valley Creek from the Warrior River (Stations 12, 11, 6 and 5). The 1968 sampling period revealed reductions of 44, 80, and 35% at 18, 11, and 7½ (Stations 12, 11 & 6) miles, respectively, up Valley Creek, but showed an increase of 263% when compared to check samplers at 3 miles above the Warrior River in Valley Creek. Stations at 200 yards and one mile up Valley Creek showed an increase of 264 and 459%, respectively, during the August, 1968, sampling period.

## Toxicity Profile in Valley Creek

The increase in chironomids during August, 1968, indicates heavy enrichment during this period. There was a slight increase during the May sampling period. It appears likely that drought periods or light rain periods resulted in considerable enrichment in the lower reaches of Valley Creek, hence the increase in chironomids.

This hypothesis appears to be strengthened by the environmental conditions which historically precede fish kills in the lower reaches of Valley Creek. Long droughts followed by heavy rains have preceded all fish kills investigated by Fisheries Section biologists in the Valley Creek area.<sup>2</sup> High B.O.D. effluents from municipal and industrial plants up Valley Creek settle out in the upper reaches, and, when heavy rains occur the effluents are scoured from the bottom, oxidized rapidly, and a slug of low-dissolved-oxygen water is passed downstream. During low rainfall periods, the effluents are not scoured from the bottom and subsequently are oxidized very slowly. The slow release of nutrients from oxidized material serves as added enrichment in the lower reaches of Valley Creek.

The fact that repopulation into the fish kill area occurs rather rapidly indicates that environmental conditions, except when the rains occur, are suitable for aquatic life.

During the May, 1966, sampling period, 1.11 in. of rain fell in the Jefferson County area; during the August, 1968, sampling period, 0.62 in. of rain fell. Since chironomid survival and/or repopulation was greater during the August, 1968 sampling period, and since the rainfall was less during the same period, an inverse relationship is suggested.

These data are inadequate to draw definite conclusions regarding water quality degradation in Valley Creek, but it is hoped that additional data using this same technique will furnish the needed information.

### LITERATURE CITED

1. Hester, Eugene F. and J. S. Dendy. 1962. A multi-plate sampler for aquatic macro-invertebrates. Trans. Amer. Fish. Soc. 91:420-421.
2. Tatum, Walter M. 1965. Bioassay of industrial pollution by use of masonite plate samplers populated with chironomids. Proc. 19th Annu. Conf. S. E. Assoc. Game and Fish Comm.:253-258.

---

<sup>2</sup>State of Alabama, Department of Conservation, Annual Report 1965-66.



SOME LITTLE KNOWN PLANTS IN ALABAMA

Blanche E. Dean  
Goodwater, Alabama

The flora of Alabama is remarkable for its distribution and number of species. Dr. R. M. Harper spoke of certain places as Botanical Bonanzas. One in particular he mentioned occurred in Greene County where he found a rare species of crowfoot, *Ranunculus flabellaris* Raf.<sup>1</sup> I would like to introduce you to at least two other places interesting to me for the same reasons. One is in Blount County near Hayden where, in 1966, I found the rare *Andrachne phyllanthoides* (Nutt.) Muell. Arg., a member of the Euphorbiaceae; the first find of the plant growing east of the Mississippi River. It seemed to be growing well with roots twisted around boulders in the sand and in close proximity to water. Other plants growing in association with it were *Cornus stricta* Lam., *Amorpha virgata* Small, *Nyssa biflora* Walt., and *Rhododendron* sp. Silky camellias, *Stewartia malacodendron* L., were growing on the hill above the stream.

The other place, which is somewhat like a pocosin on a long high hill, is near Maplesville, Alabama in Chilton County. A highway runs through the middle, greatly reducing the size of the area. Sundew, *Drosera intermedia* Hayne, butterwort, *Pinguicula lutea* Walt. colic root, *Aletris aurea* Walt. and *A. farinosa* L., orchids, *Pogonias* and grass pinks, *Calopogon*, clubmoss, *Lycopodium carolinianum*, queen's delight, *Stillingia sylvatica* L., pineland ginseng, *Tetragonotheca helianthoides* L., deer's-tongue, *Trilisa odoratissima* (Walt.) Cass. (leaves are hunted for the coumarin used for flavoring) were growing there. Harper's ginger, *Hexastylis speciosa* Harper, thought to live only in Autauga County was growing there as well as two other gingers. There were also ferns including cinnamon, royal, lady and net - veined chainfern. Among the trees were arkansas oak, *Quercus arkansana*, Sarg., Boynton's oak, *Q. boyntonii*, pyramid magnolia, *Magnolia pyramidata*, Pursh, and sweetleaf, *Symplocos tinctoria* (L.) L'Her.

Another little known plant in our state is grass-of-parnassus, *Parnassia asarifolia* Vent., which grows in Clay County, in the Shinnel Valley and in other places in the Piedmont. In one place in Clay, I found it growing and blooming the last week in October among the seed stalks of the white-fringeless orchids, *Habenaria blephariglottis* (Willd.) Hook var. *integrilabia* Cor.

Another rare orchid, *Isotria verticillata* (Willd.) Raf., was rediscovered by Lester Hart in May, 1969. No doubt, it is still growing where E. A. Smith found it in Tuscaloosa County almost a century ago. Then it was known as *Pogonia verticillata* Nutt. This orchid had not been seen for many years.

There are several *Trillium* spp. in the state which seem to be well-known, but one, *T. decumbens* Harbison, which grows only in Alabama, seems not to be known. It comes early in the springtime, appearing to bloom out of

<sup>1</sup>Harper, R. M. 1965. A botanical bonanza in the Black Belt. J. Ala. Acad. Sci. 36:67-73.

## Little Known Plants in Alabama

the ground. The plant grows along the leaf litter or soil. The leaves are small, highly marked; the flowers brown, sessile. It grows in colonies. Another dainty small trillium, *T. pusillum* Michx., has been found growing in a marsh which is soon to be drained. It has white to pink petals that age to purple, lanceolate leaves and sessile flowers.

The following plants are little known but are found over the state. Alabama croton, *Croton alabamensis* E. A. Smith, was discovered by E. A. Smith on the banks of the Little Cahaba growing in thickets under Durand oaks. A member of the Spurge family, it has beautiful silvery leaves and yellow flowers. Since it is evergreen and the seeds are as lovely as the flowers, it could be used to beautify our highways, both in winter and summer.

Among the several rhododendrons suited to this zone is the beautiful *Rhododendron alabamensis* Rehd., sometimes referred to as Alabama azalea. It has lovely white fragrant flowers with the upper petal of each flower marked with a yellow spot. They can be transplanted easily.

In north Alabama, the smoke tree, *Cotinus americanas* Nutt., could fill a need for shrubs in yards and along roadsides. It flowers in springtime and exhibits brilliant scarlet and orange-colored leaves in the fall. The smoke tree grows from eastern Tennessee to west Texas, but no where is it common. There are a number of smoke trees growing wild in Madison and Morgan Counties.

Not to be overlooked are the silver bells and the storaxes. Several species of *Halesias* and *Styraxes* grow over the entire state. They are most beautiful in springtime.

At least two of the hydrangeas, better known as "seven bark" and "nine bark", are almost limited to Alabama. One species with two subspecies, but not our oak-leaf hydrangea, *H. quercifolia* Bartm., is listed in *Vascular Flora of the Carolinas*. The one called "nine bark", *H. arborescens* L., is a lovely plant, bearing white flowers in corymbs. Both it and *H. quercifolia* could add to projects of beautification of yards and highways. There are more of these two hydrangeas in Alabama than in all the rest of the world put together. They are abundant near the roads and can be transplanted easily; it is a shame they are not more appreciated. I should not fail to mention the climbing hydrangea, *Decumaria barbara* L., though it is not suited to highways. The glossy green leaves, the white flowers and the singular-looking seed vessels make it of interest where a vine is needed.

The red buckeye, *Aesculus pavia* L., is beautiful and well-known, but the white buckeye, *A. parviflora* Walt., sometimes called "bottle brush", is quite handsome and scarcely known. The only place in the world to see white buckeye is in Alabama and west Florida.

Neviusia was found growing on the Warrior River in 1853 or 1854 by R. D. Nevius, an Episcopal minister with a botany hobby. A specimen sent to Asa Gray for identification was named for him, *Neviusia alabamensis* Gray. It is a member of the Rose family. It has clusters of snow white

flowers and is sometimes called "snow wreath". It is well worth a place in your yard.

*Polymnia canadensis* var. *radiata* L. with its white rays is our most common polymnia. In the proper habitat it is found throughout central and north Alabama.

The Bankhead Forest is truly a bonanza. However, space will allow mention of only a few plants that grow there, namely, Allegheny spurge, *Pachysandra procumbens* Michx.; columbo, *Swertia caroliniensis* (Walt.) Ktze.; round-leaved catchfly, *Silene rotundifolia* Nutt.; and two filmy ferns, *Trichomanes boschianum* Sturm and *T. petersii* A. Gray.

Yes, Alabama has a great abundance of plants. They should be more appreciated, and they could be and would be if all of us would take the time and trouble to introduce our children to the beauties of the world around us. With some help our highways could be made more attractive to us, as well as to the tourists.

# Index

## INDEX

Absorption, Magnetic Resonance, Within the Non-Kramers Doublets....	155
ACTH Secretion in Rats, Effect of Reserpine and Alpha-methyltyrosine .....	119
Acton, J. C., Jr. ....	216
Agriculture, Alabama, Brief History of .....	174
Ainsworth, Charles H. ....	203, 204
Alabama Academy of Honor, Formation of .....	184
Algae of Calhoun County .....	127
Algorithm, Fortran, Expansion of Computer Memory .....	201
Amphibians of Mobile County .....	133
Amplitudes, Light and Electrical Pulse Correlation in Proportional Counter .....	155
Analysis, Structural, of Jeff Price Mine, Cave-In-Rock, Illinois .....	142
Analyzer, Probability Density .....	199
Anisotropic Material, Wave Propagation in .....	203
Anniston, Alabama, Early History .....	171
Antennas, Receiver, for Application in Television Relay System .....	200
Apples, Increased Disease Susceptibility Associated with Russetting .....	129
Aquifers, Alluvial, Location and Definition of Along Alabama River .....	146
Atwood, J. L. ....	137, 140
Azygiidae (Trematoda) Populations in <i>Percina nigrofasciata</i> .....	117
Bacon, Warren A. ....	140
Bacteria, Analysis of Swan Creek, Alabama .....	122
Ball, F. L. ....	181
Bamboo, Pilot Study on The Ecology of .....	124
Barisa, B. B. ....	202
Barite, Deposits in Bibb County, Alabama .....	143
Barr, T. A., Jr. ....	254
Bateman, Darrel .....	117
Beals, Harold O. ....	58
Beam, Wayne .....	120
Bean, Peroxidase Activity in Hypocotyls .....	123
Beniwal, S. P. ....	117, 129
Benton, Phil C. ....	175
Bernard, Simon, and the Fortifications Board .....	169
B-Hydroxybutyrate, Metabolism in Rat Brain .....	191
Biota of Black Warrior and Tombigbee Rivers, Adverse Effect of Industrial Wastes on .....	135
Birds, Wading, Vocalizations of .....	123
Birds, Wading, Wheeler National Wildlife Refuge .....	134
Blair, M. A. ....	136
Blood, Horse, Flow in Response to Catechola-mines.....	195
Bloomer, John W. ....	168
Boa Constrictor, Anatomy and Physiology of Arterial System .....	189
Boone, Marshall N., Jr. ....	175

# Journal of the Alabama Academy of Science

Borazine, N-methyl Derivatives of .....	140
Bourne, J. R. ....	125, 131
Bowden, C. M. ....	155
Bowie, W. C. ....	195
Bradford, B. N. ....	130
Bradley, Martha ....	117
Bramlett, C. L. ....	139, 140
Brannon, Evelyn ....	208
Brezovich, I. A. ....	155
Briscoe, J. Martin, Jr. ....	176
Brockman, George F. ....	141
Burgess, Barry ....	141
Burns, Mary Leslie ....	118
Cahoon, Elizabeth ....	142
Caldwell, Robert C. ....	176
Cameron, Marguerita L. ....	205
Capps, Julius D. ....	136
Carbon Disulfide, Electronic Absorption Spectra .....	139
Carmichael, Emmett B. ....	177, 178
Carter, John T. ....	169
Casey, Albert E. ....	184, 186
Cash, Anna G. ....	188
Castizo and the Jade God .....	206
Causey, M. Keith ....	151
Chafin, Brenda R. ....	178
Chapman, W. Eugene ....	142, 143
Chase, David W. ....	205
Chemistry, Curriculum at a University College in Ghana .....	138
Chennareddy, Venkareddy .....	3
Cherng, Maw Jian ....	189
China Trade, Revisited .....	110
<i>Chlamydomonas</i> , Comparison of Soluble Proteins .....	25
Chloroplasts, Large Scale Isolation in Zonal Ultracentrifuge .....	183
Chynoweth, R. J. ....	162
Clark, Charles E. ....	179
Clark, E. M. ....	118, 133
Clark, Floretta G. ....	165
Clark, Neil P. ....	165
Cline, George B. ....	178, 179, 180, 181, 183, 191, 192, 193, 196
Clonts, Jerry ....	128
Cochis, Thomas ....	127, 128
Collins, R. J. ....	119
Confederate Military Prisons .....	49
Container Effects, Investigation of High Speed Impact .....	197
Cook, Betty ....	119
Coosa Deformed Belt, Definition of .....	144
Copeland, Charles W. ....	145
Copping, Leonard G. ....	120
Cormany, David W. ....	197
Corn, Polyphenol Oxidase Activity in Virus Infected .....	117
Corn, Senescence Affected by Atrazine .....	120
Cotton, Corn, Effect of 2, 4-D on Water Relations .....	124
Cotton, Effect of Atrazine on Leucine Incorporation and Phosphate Uptake .....	130

# Index

Cowsar, Donald R. ....	137
Cox, Betty .....	181
Crayfish, Chlorinated Hydrocarbon Residues in .....	131
Creep Flow with Non-Vanishing Velocity Normal to Plane Boundary .....	199
Crenshaw, Jack W. ....	156
Crispens, Charles G., Jr. ....	182
Curl, E. A. ....	120, 121
Cusp Phenomena, Associated Production of Elementary Particles .....	161
Cyclopropane, Reactions of Electron Deficient Boron Cage Systems with .....	139
Dagg, C. P. ....	182
Dagg, Martha K. ....	178, 183
Daniels, Army, Jr. ....	156
Davis, D. E. ....	120, 124, 130, 132
Davis, James R. ....	148
Davis, Virgil S. ....	169
Dean, Blanche E. ....	121, 278
DeAugustine, Peter .....	122
Deer, Rutting Season in Alabama .....	150
Deer, White-tailed, Movement in Sumter County, Alabama .....	151
Dehydrogenase, Glutamate, Alterations in Properties of .....	179
Dehydrogenase, Glutamate, Study in Alteration in Catalytic and Regulatory Properties .....	190
Deinhardt, F. ....	181
Delaney, Joseph .....	170
Dezenberg, George J. ....	157
Dickinson, Cathy .....	183
Dickson, W. J. ....	131
Dimethylberylliumdiquinclidine .....	140
Dismukes, John F. ....	133
2,5-dithiahexane, Electron Structure and Stereochemistry .....	136
Dobbs, Danny M. ....	143
Dobie, James L. ....	143
Dogs, Left Ventricular Pressure and Diameter in .....	175
Douty, Helen I. ....	170
Downey, Eleanor L. ....	184, 186
Drahovzal, James A. ....	144, 145
Driscoll, Boyce N. ....	206
Duckett, Charles .....	122
Duncan, W. Jack .....	17, 173
Dusi, J. L. ....	117, 123
Edwards, A. C. ....	123
Edwards, Thomas R. ....	210
Egrets, Daily Movement and Flight Behavior .....	117
Egret, Ecto- and Endo- parasites of .....	133
Electron Microscopy, New Method for Preparation of Zonal Fractions for .....	192
Electron Beams, Propagation of High Voltage, High Intensity .....	100
Embryo, Chicken, Lecithin Synthesis in .....	189
Erdey, M. R. A. ....	198
Ermer, Gene .....	246
Erythrocytes, Human, Effect of Storage on Sodium Transport by .....	195



Essenwanger, Oskar M. ....	158
Ethnobotany, Problems in Research in the Southeast .....	205
Eutaw Formation, Origin of Oyster Bank in .....	140
Evans, E.M. ....	119
Factor Analysis, Application to Socioeconomic Data in Tennessee Valley .....	3
Falkenberry, N. R. ....	186
Fatting, W. Donald .....	191, 196
Fenn, Hollis C. ....	165
Fermi Surfaces, Significance of the Phase Factor in Experimental Measurements .....	159
Ferns, Ecology of on Cypress Creek .....	125
Fibrin, Preparation of Large Sheets in Zonal Rotor .....	180
Fields, Stanley A. ....	250
Fiterre, Rafael M. ....	159
Flikke, Arnold M. ....	198
Flowers, Summer, of Northeast Alabama .....	128
Fossil Calendars, History of Earth-moon System .....	141
Foster, Howard J. ....	159
Fungi, Plant Pathogenic, Effect of Fertility and Biotic Factors on .....	121
Furman, W. L. ....	159
Galloway, Juanita M. ....	124
Gamma Rays, Undergraduate Experiment on Interaction with Matter ...	164
Garrett, J. Marshall .....	183, 186
Gaudin, David .....	185
Geer, William D. ....	232
Geology, Stratigraphy and Historical, of Talledega Group .....	148
Geomorphology, Quantitative, Link Between Hydrologists and Geomorphologists .....	147
Gerin, M. G. ....	185
Gilbert, Fred E. ....	186
Glass, Sarah A. ....	206
Glucose, Determination Polarographically .....	126
Godwin, D. H. ....	186
Gold Mining in Alabama .....	42
Gossett, Glen A. ....	137
Gradients, Sucrose Density, Sample Capacity of .....	179
Graf, E. R. ....	200
Griffitts, Fred A. ....	138
Grignard Reagents, Reactions with Indene, Fluorene and Heterocyclic Analogues .....	137
Gudauskas, Robert T. ....	117, 129
Gunther, William D. ....	225
Gussow, Sidney S. ....	198
Hafling, Mary E. ....	166
Hagerty, J. P., Jr. ....	171
Hales, W. L. ....	34
Hansen, Asael T. ....	207
Harris, W. W. ....	181
Hayes, A. Wallace .....	194
Hay Hollow Valley, Northeast Arizona, Relation of Energy Depletion and Architectural Features .....	206
Hays, H. D. ....	149

# Index

Helminth Fauna of <i>Etheostoma stigmaeum</i> and <i>E. Whipplei</i> .....	118
Hendrick, James G. ....	198
Henequen, Glimpses of Yucatan's .....	207
Henry, J. Leonard .....	128
Henson, Curtis T., Jr. ....	110
Hermanson, Ronald E. ....	198
Herons, Daily Movement and Flight Behavior .....	117
Hill, J. B. ....	188
Hisey, Alan .....	187
Holmes, A. W. ....	181
Hopkins, John R. ....	124
Hopper, William A. ....	199
Hudson, D. K. M. ....	125
Hulsey, Billie Sue .....	187
Hunnicut, Catherine .....	125
Hutcheson, G. J. ....	263
Ibises, Daily Movement and Flight Behavior .....	117
Icenogle, David W. ....	149
<i>Ichthyomyzon gagei</i> , Somatic Chromosomes of .....	122
Inclusion Body, Isolation from Boll Weevil .....	193
Index .....	281
Ingram, Sammy W., Jr. ....	138
Instalment Lending in Alabama .....	232
Jackson, T. G. ....	139
January Term, Samford's Transition to .....	173
Jemmali, Mongi .....	126
Johnson, Kenneth R. ....	42
Kennedy, H. G. ....	130
Kidney Cell Components, Human, Characterization of .....	181
Kinsaul, Regina J. ....	207
Kirklin, J. W. ....	216
Knox, H. H. ....	160
Koch, Walter F. ....	150
Kouchoukos, N.T. ....	216
Lactic Acid Disappearance and Oxygen Debt Payment Following Exercise .....	185
Lalor, William F. ....	202
Landers, Kenneth .....	127, 128
Language, Foreign, Effect of Exposure While Asleep in Learning .....	169
Lasers, CO <sub>2</sub> .....	157
Lasers, N-CO <sub>2</sub> .....	263
Latham, A. J. ....	129
LDH Virus, Effects of Statolon on Multiplication .....	182
Leathers, Charles G. ....	240
Le Prince, Joseph A. ....	178
Leverett, Sheryl L. ....	194
Lindsey, Carl .....	131
Lindsey, Donald W. ....	129
Lindsey, R. H. ....	187, 188, 197
Linzey, Donald W. ....	64
Liu, C. K. ....	199
Lloyd, R. A. ....	188
Loomis, J. M., III .....	200
Lueth, Francis X. ....	150
Lunar Materials, Coefficient of Friction in Simulated .....	250

# Journal of the Alabama Academy of Science

Lyle, J. A. ....	118, 133
Lysosomes, Isolation from Rat Brain in Zonal Rotor .....	196
Maehl, William Harvey .....	172
Mammals of Mobile and Baldwin Counties .....	64
Maneuvers, Swingby, About Natural Satellites .....	156
Mapping, Computer, Simple Techniques .....	153
Marijuana Legalization, Opinion Survey of Montevallo University Students .....	204
Mars Surface Samples Automated Return to Earth .....	202
Martin, J. B. ....	130
Mathematics, Transfer Curriculum for Two Year Colleges .....	159
McDonald, D. A. ....	189, 195
McKinney, B. G. ....	202
McMillan, Thomas A. ....	58
Medical Record, Care Oriented .....	160
Mercer, Garry C. ....	49
Merkel, Susan V. ....	208
Merritt, James A. ....	139
Mesel, Emmanuel .....	160
Metallic Materials, Evaluation of Toughness .....	200
Meyer, H. C. ....	155
Milk, Effect of Quota Plans on Supplies in Alabama .....	164
Miller, T. G. ....	160, 161
Mims, A. J. ....	164
Minutes, Annual Business Meeting .....	218
Mitochondria, Ion Effects on Zonal Fractionation .....	196
Mobile Bay, Battle of, March 14, 1780 .....	170
Moon, Processes Resulting in Concentration of Mineral Species on .....	146
Monti, John .....	189
Moody, Raymond D. ....	151
Mora, E. ....	132
Moravec, George F. ....	143
Mortar, Sea Coast, Recovery from Baldwin County, Alabama .....	58
Mott, P. A. ....	133
Mount, Robert H. ....	153
Mucosa, Gastric, Inhibition of Spontaneous Motility in .....	183
Multiparameter Optimization Applied to Spectral Data .....	210
Myxovirus-like Particles, Isolation from Hepatitic Tissue .....	181
Nashida, Mikio .....	190
Neathery, Thorton L. ....	144
Nelson, Bruce R. ....	200
Nematode Populations and Enzyme Activity, Related to Soil Fertility .....	119
Networks, Constant Resistive, Rectangular Diagram Representation .....	198
Networks, Phase Difference, Computer-aided Design .....	198
Nichols, W. W. ....	189
Nitrogen and Oxygen, Liquid, Scintillation Properties .....	160
Noble, Robert Earnest .....	177
Noland, LLOYD .....	177
Norris, J. E. ....	139
<i>Notropis ardens</i> , Study on Food Habits of .....	135
Oakley, Carey B., Jr. ....	209
Odom, Pat R. ....	202
Odor Removal .....	202

# Index

Orchids of Alabama .....	120
Ordovician, Upper, Definition of in Alabama .....	144
Organization Theory, An Engineering Tool .....	201
Orthography and Reading .....	173
Ottis, Kenneth .....	119
Overton, E. B. ....	139
Owens, James R. ....	130
Patients, Critically Ill, Automated Treatment of .....	216
Peanuts, Effect of Combine Parameters on Harvesting Damage .....	202
Peanuts, Effect of Free Moisture on <i>Cercospora</i> Leafspot Development .....	133
Peanut, Influence of Light and Starch on <i>Cercospora</i> Infection .....	118
Pecan, Cultivation in Mobile County, Alabama .....	152
Pecan, Sanitation Guidelines for Processing Plants .....	168
Pecan, Separation and Identification of Organic Compounds in Hulls .....	138
<i>Pelodera</i> sp., Histochemical studies on .....	132
Pentachlorobenzene, Formation of By-Products in the Nitration of .....	139
Penuel, Kenneth M. ....	202
Peroxisomes, Isolation from Rat Tissues .....	191
Phillips, John F. ....	131
Phosphorus, Inorganic, Correlations with Hospital Discharge Diagnoses .....	186
Physics, Teaching, Computers in .....	163
Pinson Cave, Preliminary Investigations at .....	209
Plant Cell Components, Preparation by Zonal Centrifugation .....	178
Plant, Microautoradiography of <sup>14</sup> C-labeled .....	134
Plants, Aquatic, Effect on Nutrient Depletion from Sewage-Enriched Water .....	132
Plants, Big Creek Lake Biological Station, Mobile .....	135
Plants, Little Known, in Alabama .....	278
Planz, Edward J. ....	200
Plasmas, Pinched, Improved Stabilization in Curved Tubes .....	254
Point Transformation Method .....	164
Polk, R. G. ....	161
Pollution, Air, Final Results of Tuscaloosa Study .....	149
Polynomials, Hermite, Relation Between Integrals .....	161
Powell, William J. ....	145
Price, James W. ....	201
Proteins, Salivary, Effect of Neuramidase on Properties of .....	176
Protozoa of Limestone County .....	125
Pruitt, Kenneth M. ....	176
Pyrimidine Synthesis, TSH Stimulation of .....	188
Quinn, Gerald C. ....	136
Raney, Donald C. ....	197
Raymond, Dorothy E. ....	144
Region Perception in Alabama .....	150
Regional Research, Economic Models in .....	225
Respiration, Mitochondrial, Effects of Chloroquine as an Inhibitor .....	175
Rickoll, Wayne L. ....	191
Riggsby, Earnest D. ....	166
Ritter, Gerhard, and the Militarism Problem .....	172
Robertson, Lawrence C. ....	139
Roberts, T. G. ....	34, 100, 254, 263

# Journal of the Alabama Academy of Science

Robinette, D. Lamar .....	151
Robinson, C. A., Jr. ....	191
Robinson, E. L. ....	155
Rodriguez-Kabana, R. ....	119, 121, 126, 132
Rogers, H. ....	132
Rouse, Gerald L. ....	172
Rubratoxin B, Excretion and Distribution in Male Mice .....	194
Rush, J. Edwin, Jr. ....	161
Ryel, Elaine M. ....	192
Ryel, Richard B. ....	192, 193
Saccharin Content of Liquid Foods, Method for Estimating .....	136
Salt Creek Site in Southwest Alabama .....	205
Samplers, Masonite Plate, for Toxicity Profile in Valley Creek ....	273
Scarborough, Leon .....	146
Schwarz, Guenter .....	163
Science Education, Cardboard Computer as a Tool .....	166
Science Education, Electricity and Earth Workshops for Teachers ...	166
Science Education, Role of Cardboard Carpentry in Teacher Preparation .....	165
Science, Instruction Using Systems Concepts .....	165
Science, Physical, Time Sharing in Teaching. ....	156
Scintillators, Technique for Measuring Light Output and Decay Time vs. Wavelength .....	161
<i>Sclerotium rolfsii</i> and <i>Sclerotinia trifolium</i> , Effect of Herbicides on .....	120
Scott, A. Floyd .....	133
Scott, David L. ....	135
Sebastian, Glenn R. ....	152
Sediment, Distribution Along Southwest Coast of Alabama .....	143
Sediment Environment, Southwest Alabama Gulf Coast .....	141
Seek-It, Three Years Later .....	167
Settlement Patterns, Nucleated Rural Nonfarm, Upper East Tennessee .....	149
Shatas, Romas A. ....	38, 161, 162
Shell, William B. ....	167
Sheppard, L. C. ....	216
Shoemaker, R. L. ....	183, 186
Shotts, Reynold Q. ....	146
Signals, Pseudo Random, Telemetry System Testing with .....	203
Single Tax Colony, Legal and Economic Aspects .....	9
Smith, Johnny Mac .....	168
Smith, Karen L. ....	194
Smith, Wesley G. ....	3
Somatology, History and Present Status .....	170
Somatometry, Proportions and Disproportions .....	208
Space Acquired Data, for Geologic and Hydrologic Research .....	145
Space-Technology Transfer, Barriers to .....	246
Speake, Dan W. ....	153
Speigner, B. C. ....	147
Sphincter, Opossum Gastroesophageal, Manometric Characteristics of .....	186
Spitzer, H. L. ....	189
Stanton, Willys G. ....	201
Stettler, John D. ....	38, 161
Stewart, Dorothy A. ....	162

# Index

Stewart, G. T. ....	9
Stuart, Jeanne J. ....	133
Subirats, F. J. ....	118, 133
Sulcer, J. R. ....	202
Surface Tension, Aqueous, Molecular Depression of ....	187
Tabereaux, A. T. ....	140
Tarvin, J. T. ....	164
Tatum, Walter M. ....	273
Taylor, R. E., Jr. ....	195
Taylor, Ronald S. ....	140
Tax, Alabama's State and Local Burden ....	240
Teratogenicity in Mice, Maternal Effect on Azauridine ....	182
Thermal Scale Model with Experimental and Theoretical Results ....	201
Thiouracil, Pathways for Incorporation into RNA ....	197
Thomas, William A. ....	144
Three Stars and a Wreath, Alabama Style ....	168
Thyroids, Porcine, Histone Metabolism in ....	187
Time Periods, Meteorological Parameters for Arbitrary and Natural ....	162
Tortoises, Gopher, Preliminary Results of Gassing Tests in Gopher Burrows ....	153
Traylor, Charles T. ....	153
1, 1, 3-Tribromoacetone, Mechanism of Favorsky Rearrangement of ....	137
Truelove, B. ....	123
Tucker, Robert G. ....	25
Tumors, Effect of DNA Repair Inhibitors on ....	185
Turkey, Wild, Distribution in Alabama ....	148
Turner, Carlton M. ....	201
Turner, Jack, Lynching of in 1882 ....	172
Turtle, New Species of Dermotemydid ....	143
Vaughan, A. W. ....	125
Vectorial Method, Its Power and Elegance ....	159
Velocities, Spectroscopic Measurements in Jets ....	34
Ventricular Volume Measurements, Apparatus for Studying the Thermolulution Method ....	188
Verstehen, Epistemological Significance in Management ....	17
Vess, David M. ....	173
Vibrators-Rotators, Non-Rigid, Procedure for Energy Calculations ..	38
Virus, Maize Dwarf Mosaic, Affected by Some Systemic Pesticides ...	129
Virus, Nuclear Polyhedrosis, Zonal Purification ....	192
Voight, Roger W. ....	195
Warren, Ray N. ....	148
Watershed Research, Digital Data Acquisition System for ....	198
Weathers, G. D. ....	203
Webster, J. E. ....	189, 195
Weeds, Aquatic, Water Quality and Nutrition Studies on ....	130
Weinberger, Phillip C. ....	196
Weller, Edwin ....	189
Wells, F. T. ....	202
Werkheiser, A. H. ....	160, 161
Westover, Frederick L. ....	173
Wheelahan, Edmund J. ....	200
Whiteley, A. R. ....	134
Whitt, C. D. ....	140
Whittmann, H. R. ....	162



# Journal of the Alabama Academy of Science

Wildlife Management and Compatibility with Forestry .....	151
Williams, Charles Oliver .....	203
Williams, George Jr. ....	134
Williams, Louis G. ....	135
Williamson, Janice .....	196
Wilson, Lowell E. ....	164
Wind, Profile Structure and Geographic Distribution of Models .....	158
Wisdom, Nalria Jean .....	135
Witriol, Norman M. ....	164
Wofford, Eugene .....	135
Wong, M. Y. ....	197
Wood, Silicified, from Alabama Coastal Plain .....	142
Ute Indian Today .....	203
Yarbrough, James D. ....	25
Yeager, J. H. ....	174
Yielding, K. L. .... 175, 179, 181, 185,	190
Zatko, D. A. ....	136
Zero-Phonon Lines, Temperature Effects on .....	162















my of Science. Journal.  
. 1969-70.

506(76.1)B

ies

APR 25 1975



N. MANCHESTER,  
INDIANA

AMNH LIBRARY



100232699